THE MONTHLY

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TRANSACTIONS

OF THE

ROYAL MICROSCOPICAL SOCIETY,

AND

RECORD OF HISTOLOGICAL RESEARCH

AT HOME AND ABROAD.

EDITED BY

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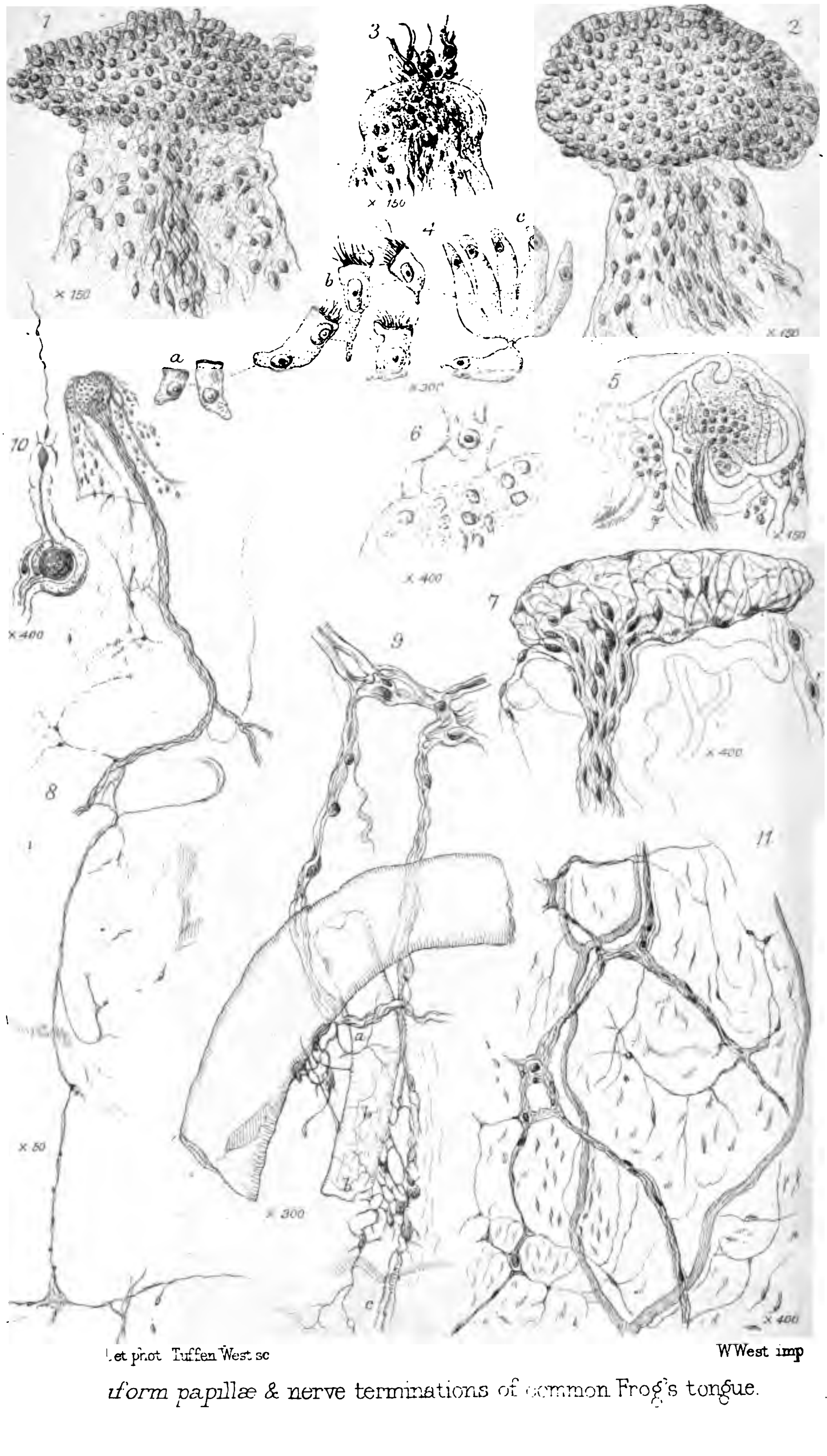

l. et phot. Tuffen West sc   W West imp

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with the tenets held respecting the primary and subsidiary functions, that we can only hope through renewed observations to harmonize the discrepancies and arrive at satisfactory conclusions. Though all addition to positive knowledge preludes further research with an authority of a substantial nature, still it is desirable to strive to establish conformity in observation by adopting some particular method, and thus procure a general credibility as one step to uniformity of results. In animal tissues prepared for microscopic investigation without this precaution, we cannot expect to arrive at similarity of opinion. Thus we should seek to employ the best-known methods for preparing specimens. Judging from the highly valuable contributions to the Royal Society by Dr. Beale, marked with originality in investigating minute structures by the highest magnifying powers, and illustrated with extreme care, I have not hesitated to adopt the method advocated by him, but which on the Continent appears set aside for less suitable plans.

In that much-examined creature the Common Frog (*Rana temporaria*), there is in the observations on the structure of the Papillæ alone, no close or common agreement amongst the numerous observers. It therefore appeared desirable to recommence the study of some parts by the same method as that adopted by Dr. Beale in his examination of the papillæ of the Hyla, especially as the animal can be readily procured, easily injected, and affords much chance of obtaining an insight into those general conditions, under which we may suppose alike functions are manifested in higher classes.

The drawings and photographs are not exactly similar to those set forth by previous observers; but there are several points which accord more with some microscopists, less with others, and the differences can be brought within a certain relation. Drawings are also given of the arrangement of nerves as applied to the surface of voluntary muscles in the tongue, and of the lax tissue beneath this organ.

It is purposed, firstly, to note the appearances presented in these different parts, and then endeavour to draw some general conclusion.

It may be necessary to premise the animal was first injected by glycerine prussian-blue solution, and that such magnifying powers only have been used for the drawings as would enable me to trace much larger surfaces than those generally given (by which the action of the various parts may be more easily estimated), and the camera lucida used for each. Hence in many places where only single fine nerve-fibres are figured, by much higher magnification they can often be shown duplicated, or to consist of even more than two fibres in conjunction at some near part of their course. The photomicrographs are added to help the illustration,

especially in those points where doubt might exist as to correct representation, irrelative of interpretation. In some cases I have endeavoured to stain the tissues by a method different to any hitherto proposed, and have so far succeeded as to give me hope, by further efforts, to be enabled to stain the delicate nerve-tissues of a decided tint, in specimens even which have already had the germinal matter stained by carmine.

If, as is generally allowed, we regard the glossopharyngeal nerve as the special sensory nerve of taste, and the fungiform papillæ as the chief seat of the sensuous impressions; and if we give to the frog the same power as we possess ourselves, of discriminating between agreeable and disagreeable substances, we may leave the fine distinctions brought about by habits of cultivation: and I see no reason why this should not be allowed, noting the instincts of various animals and the results of experiments, where the power of selection has been lost by sections of this nerve. Presuming this, I shall regard these fungiform papillæ in the frog as the chief organs of taste.

Whether the general organ is, as stated by the late Dr. Henry Goadby, rendered turgid at the moment of its eversion from the mouth in the act of seizing its living food, I am not prepared to state, for I have not been able to satisfy myself on this point, or whether these fungiform papillæ are erectile or retracted under use, I cannot decide, though often tempted to suppose such to be the case from the position of the fine terminations of the branched muscles within them; and if we take for granted, so far as taste is concerned, the necessity for substances to be presented to the papillæ in solution, we shall be the better enabled in the details following to assume the action of various parts.

Amongst the fungiform papillæ there is considerable difference in appearance as to size and contents, though all bear a general uniformity. This we may expect from partial destruction of such delicate organs, or from the variation between those fully formed, and those growing or under repair.

The close arrangements of the gustatory and filiform papillæ; the passage in the same bundle with sensory nerves going directly to the summit of the former, of fine nucleated nerve-fibres; their distribution to the capillaries of the papillæ, the branched muscular fibres attached at their attenuated extremities to the sides and near the top of the fine connective tissue that surrounds them, and to the adjoining or neighbouring filiform papillæ and their capillary; show that within the same bundle with sensory fibres we have also excitor and reflex fibres in such a complicated arrangement, that it would be impossible from experiments conducted on the surface of the tongue to establish any satisfactory results; or separate the functions of taste from touch, could we experiment on the frog,

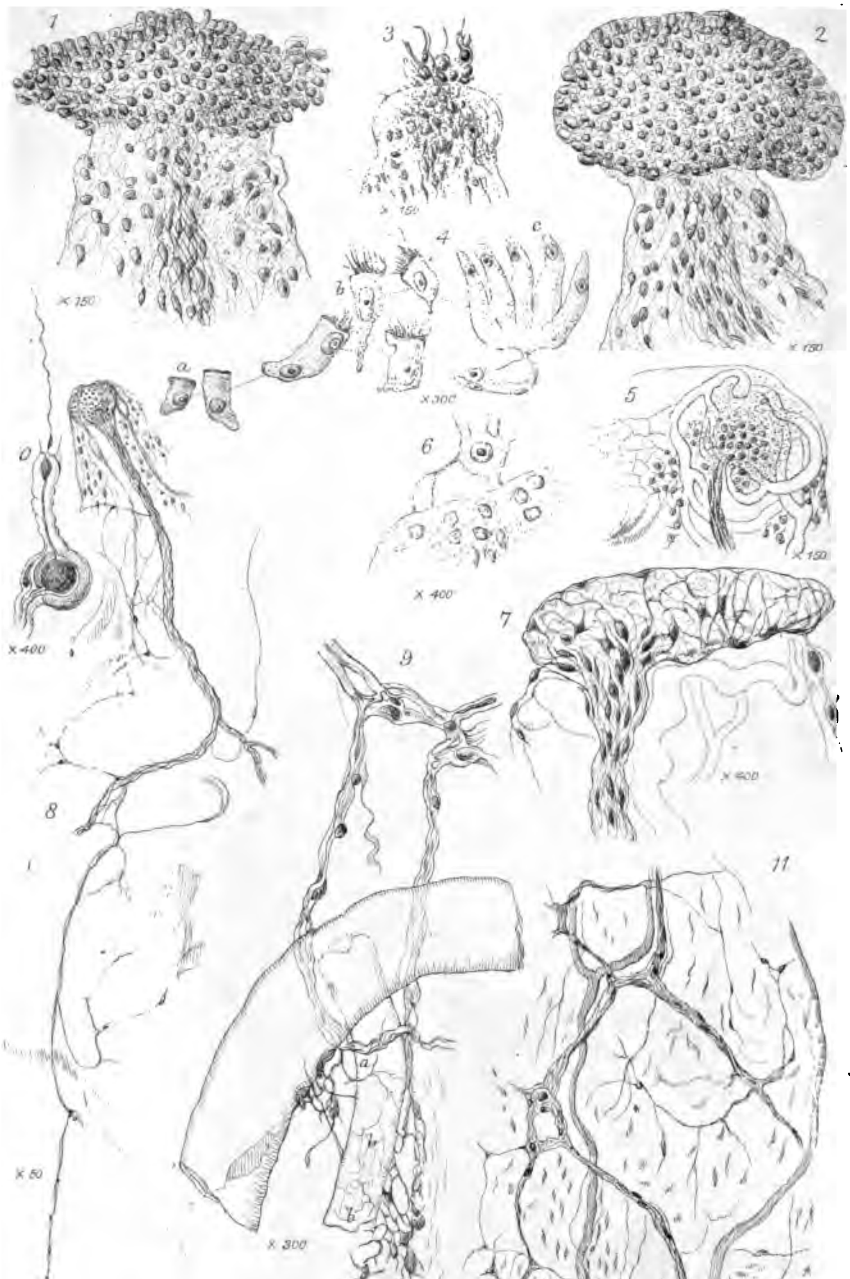
where the parts are so beautifully distinct in sections under the microscope.

As in the experiments on mammalia, in which the glossopharyngeal nerve, when excited indirectly, influences the contiguous muscles and vessels from afferent and efferent fibres at the spinal end and ganglionic system, so we find we have here within a very small compass a wonderful arrangement to carry out the complex function of a single papilla; nor must we lose sight of direct sensitive, motor, and ganglionic fibres given to all parts of the tongue, which will help to explain the combined sense of taste and touch or roughness; and the induced action of swallowing when the back part of the tongue is irritated or supplied with any object of taste; as well as the rapidity with which the secretions of the mucous crypts or follicles may by such be influenced. When we come to question why one substance should be bitter, another sweet,—one styptic or rough as alum, another soft or bland as gum,—whether the solutions of these various bodies excite mechanical, chemical, electrical, or thermal impulses, which normally affect the terminal plexus after a constant manner, or whether there yet remains an impulse of a character which does not belong to the domain of the known forces, is a matter of speculative philosophy; and the more difficult becomes the question of the real value of each part or their relative functions, when we find that for all substances to produce the sensations of taste, it is not necessary they should be directly presented to the tongue or the outside of the papillæ; as the taste of many can be conveyed by the blood through absorption into the system. Possibly some real change of a more or less temporary nature is produced in the condition of the sensory nerve; its statical state, so to speak, is disturbed; sometimes heightened for the reception of other impressions; sometimes rendered incapable of receiving them until the former impression is diminished if not entirely absent; and in severe catarrh often rendered indistinguishable; here the secretions may be so changed as to suspend the finer uses of the various parts. Indeed, seeing in our own case how much these organs are exposed to very hot or very cold bodies, how constantly their surfaces are subjected to very rough usage or abrasion under mastication of hard food, we may be surprised that the discrimination between similar substances should be so delicate; often to some extent aided doubtless by the senses of smell and touch,—in fact we could hardly expect the terminal portion of these organs to retain their integrity, unless endowed with the power of considerable resistance, of rapid reparation, or peculiarly constructed to remain in such constant readiness.

The details of some of the parts cursorily alluded to, are not of easy description, from the difficulty of deciding to which part small portions may belong when separated from the rest, and from the

doubt entertained by various observers of their true nature. If we take the whole fungiform papilla as seen under the microscope, we find at the summit most externally, a hemispherical cap, closely fitting over the top of the papilla, and which can be often removed entire from the under-surface or support, leaving this surface bald; or it can be under pressure flattened out, generally as a whole, or with only minute parts broken up into separate portions (Figs. 1, 2); at other times when removed we find no longer the bare appearance of the under-surface, but nucleated bodies or rods (Fig. 3), projecting from the exposed surface, and evidently in strict connection with the surface on which they are seated. What then is the nature of the cap and the nucleated little tuft seated beneath? I am disposed to regard the entire cap as of a mixed character; viewed on its surface it looks like a compact mass made up of a set of closely aggregated nucleated bodies, presenting externally a more or less hexagonal facetted appearance, strongly attached at their bases and sides, and individually composed at the outer part of a formed material somewhat harder than the rest, and nonciliated; having within, situated at variable positions, a mass of germinal matter or nucleus of a round or oval shape, often with a distinct nucleolus or new centre of growth, and the whole intervening portion filled with a finely granular highly refracting substance. This I regard as secreting or glandular epithelium, for, compared with the ciliated epithelium if we remove the cilia, it would be almost impossible to distinguish between them; they perhaps as a whole are of more uniform size and shape. I do not find any special difference, as noted by Dr. Beale, in the size of the nuclear bodies in the Hyla, as proportionally larger than in the ciliated variety, and which he advances with other reasons as an argument in favour of its non-epithelial character. In the frog the nuclei (Fig. 4*a*) are smaller than the nuclei of the ciliated epithelium (Fig. 4*b*); but in point of length they differ considerably from the generality of the epithelia of the mucous crypts (Fig. 4*c*), the nuclei of these being generally situated at the top or free end, though at the bases, like the first, they are structurally united by a fine granular matter, which is found in the substance of all. They would correspond with the Kelch-zellen, or calyx epithelium, of the latest writer, Engelmann, and I believe are regarded by Bilroth and Axel Key as epithelial cells, whilst Dr. Beale does not regard the cap "as an epithelial structure."

The nature of the little tuft of cylinder-like nucleated rods often left on the removal of the cap, is yet more difficult to satisfactorily determine; they are variable in number, shape, and length; are attached at their bases to the crown of the spongiform mass, and project from it, their free extremities radiating from each other under pressure: structurally, so far as I have been enabled to determine



R. L. Maddox del et phot Tuffen West sc. W West imp

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them, they present a more or less rod-like appearance, as figured by Axel Key and Engelmann, of a highly refracting nature at the extremity, slightly granular towards the base, and with a nucleus or mass of germinal matter in the substance nearer the basal extremity than the free end. In several cases, I have been enabled by careful adjustment of the illumination, to observe a darker central portion in the rod part surrounded by a highly refracting substance. These I regard, with Bilroth and Axel Key, as belonging to the sensory nerve apparatus, the latter simulating them to the olfactory cells, and not to epithelium as Engelmann supposes, who names them Cylinder-zellen, or cylinder cells. The reasons for this opinion are their remaining in connection with the sponge-like glutinous mass beneath, in which a fine plexus of nerves can be seen, and the definite character they present at the surface, where we may suppose the first impressions are made. Hence it will be asked, Do the sensory nerves of taste terminate in free ends? Not as free ends of a nerve, but as direct terminal organs consisting of nerve matter surrounding a germinal mass or nucleus; in fact I regard them, to the plexus of nerves beneath in the papilla, in the same relation as the retinal rods to the optic-nerve, but protected by a mass of secreting epithelium, which I suppose capable of aiding, by producing a fluid material, to render sapid the substances offered for taste, so that it may be presented direct, or possibly by a process of dialysis, to these terminal organs, without their being subjected to injury. Besides these distinct bodies are small masses of germinal matter situated at the bases where these bodies and the epithelia are attached, and often visible on looking down into one of the fungiform papillæ after the other parts are removed (Fig. 5); and which I regard as belonging, some to the structures proper to each as new centres of growth and repair; whilst others of these germinal masses are surrounded by fine granular matter exceedingly delicate, and I believe in structural connection with the fine nerve-plexus situated at the summit of the sponge-like mass beneath the hemispherical cap. They are represented by Engelmann as Gabel-zellen, or furcate cells. I believe they do not stand up between the epithelial and cylindrical bodies, but lie on the surface of the spongiform expansion, yet when dragged from this surface they would present more or less the appearance figured by Engelmann in Siebold and Kölliker's 'Zeitschrift' for Dec. 1867. The bifurcations or processes I think due to the nervous matter surrounding the little germinal mass, as figured by Dr. Beale in his paper on the Tongue of the Hyla, being torn away from the adjoining ones. I have drawn one such raised from the surface, as seen with its base and two of its processes attached to the spongiform mass (Fig. 6), and see no reason to separate them from the general plexus at the summit of the nerve expansion; for proceeding farther towards the centre we

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I consider them as unconnected with the sensuous nerve of taste, and belonging to the afferent or efferent nerves of the cerebro-spinal system. Dr. Beale regards them as afferent fibres of the nerve centres, the efferent fibres being distributed to the muscular coat of the small arteries. They can occasionally be traced over the capillary ring, though generally at the level of this part all the structures are very adherent, and the granular matter with the numerous nerve nuclei much obscure them. The inosculations of these capillary nerve-fibres are exceedingly numerous, and though I have traced them as connected with dark-bordered fibres through *very long distances*, and often by apparently only single fibres, their true nature is difficult to establish (Fig. 8).

On either side are the beautiful branched muscular fibres, the attenuated extremities of which, after having lost their muscular character, are inserted into the connective tissue near the summit of the papilla. In some of the fine branches, the sarcous elements seemed to dwindle down most gradually until, even with a high power, it was impossible to distinguish more than one sarcous element in the filament. The fine nucleated nerve-fibres which join dark-bordered nerve-fibres, or pass from or into the fine nucleated nerve-fibres of the capillaries course round their branches, often as a most delicate plexus, and intercommunicate amongst the other nerve-fibres which run in the connective tissue of the filiform papillæ. The mode in which some of the nerve-fibres are seen to approach the muscles will be described under Fig. 9.

Outside is the fine membrane of connective tissue inclosing the entire papillary organ as far as the neck, which I think can sometimes be traced over the nerve expansion as far as the central tuft of nucleated cylinder rods, and where these are broken away, I have seen the fine membrane covering the bald summit; but whether this may have been caused by unequal pressure forcing the fine membrane from below over the top, is uncertain, but I am disposed to regard it at this point, as a basement membrane common to the nucleated germinal masses and adjacent parts. It is continuous with the surrounding filiform papillæ, and supports, besides the ciliated epithelial structures, two kinds of mucous crypts, the circular and elongated, to which, whether examined from without or from within, I have never been able to discover any aperture or duct. When the little circular masses are picked out or pressed away, there remain distinct sharp-edged apertures in the connective tissue, corresponding to the position they occupied; whilst the elongated form I have not been able to set free in the same manner. Whether they, though so similar in their microscopic structural appearances, offer any difference in their secretions, assuming them to be secreting organs, or whether the viscidity of the frog's tongue is secreted as such, or as a thinner fluid which,

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surface of the muscle, that nerve-tufts did not exist. These appearances at least, if they do not harmonize much of the contention which I have briefly alluded to, certainly show the value of the method of preparation. They might have been more highly magnified, but to embrace all the points shown and that no mistake has been made in reference to the nerve-tissues, it was necessary to keep the magnification within due bounds. In the breast-muscle of the common frog I have seen the same arrangement, save that the nerve has often a very tortuous or knotted appearance just before dipping down between the muscles, and which I expect depends either on the way in which the original compression has been made; or else exists naturally, and permits of considerable play of the subjacent parts without detriment to the delicate adherent expansions. I am not quite prepared to admit these formations as dependent on nerve-textures in the course of formation; but rather, if they have any speciality, as belonging to fully formed structures; and that the final arrangement here is plexiform, whilst where impressions commence by contact with the outer world probably definite nerve-structures exist, varied in plan for their reception according to the nature of the primary impulse.*

* Although Dr. Beale in his 'Archives' has explicitly pointed out the views of many of the observers who differ with him as regards the relation of nerves to muscles, a short summary, borrowed in part from his Journal, may not be out of place here. I believe Rouget, Krause, Moxon, Engelmann, Kühne, Doyère, Trinchese, and several others, though differing amongst themselves as to the manner of the connection of the axis cylinder with the motor plates, "plâques motrices," yet admit these bodies as being the terminals of the nerves. Kühne considers the axis cylinder of the nerve to enter the sarcolemma in Hydrophilus and obtain contact with the contractile elements within; and in the breast-muscle of the frog that the axis cylinder passes into the sarcolemma and terminates after division in peculiar oval bodies or in pointed ends.

Kölliker does not admit the penetration of the sarcolemma by nerves, nor the existence of the peculiar bodies seen by Kühne, but considers with him that the pale fibres which Beale finds form a delicate plexus, terminate in free extremities, the axis cylinder and white substance losing their several characters. Beale maintains the fine nerve-fibres become more attenuated, and at last form a very delicate plexus with wide meshes on the sarcolemma. Kölliker distinguishes motor and sentient nerve-fibres in the breast-muscle of the frog: the motor divide and pass in a direct course to the muscular fibre, abruptly becoming pale and thin: the sentient fibres take a long course, dwindling in size until they are with difficulty distinguished from the connective tissue on and between the elementary fibres. Beale acknowledges the expansion of the nerve on the elementary muscle, but interprets it differently to Kühne; he found he could strip the peculiar cells or nuclei from the sarcolemma. He believes every thread is composed of finer threads, one thread never forming the entire boundary of a single space, though it may assist in the formation of many; that complete circuits exist which include central and peripheral nerve-cells, the latter usually regarded as nuclei which are connected by intervening fibres. He considers there are no special sensitive filaments distributed to muscle, and that the fibres in the fully formed muscle considered to be of this nature are motor; he believes those so regarded to have belonged to muscular tissue at an earlier period of life, and that the only sentient fibres of muscles are some of the filaments which leave the muscle for the cutaneous nerve-fibres and those distributed to the capillary vessels. In this very rough outline it is impossible to enter all the opinions of various parties. Dr. Beale has the advantage of

The lax tissue beneath the tongue of the frog furnishes a wonderful plexus of nerve-fibres, many of them running in the sheath of connective tissue, and being separated by very large nuclear germinal masses, which I regard as centres of nerve force. Although I have in sections of the tongue itself found these large nuclear masses (Fig. 10) but rarely; there is an abundance of pale, flattish gelatinous-looking fibres, which, whether they should be regarded as nerves in the course of further development, or decaying, or as belonging entirely to the ganglionic system, must, I think, be regarded as uncertain. In this wonderful plexus exceedingly delicate nucleated nerves can be traced for considerable distances; and many represented as a single fibre, by higher powers, are found to be formed of two or more, often twisted, as first noticed by Dr. Beale. Sometimes one of the fibres may be seen attached to the nucleus at either end, and two or more divergent fibres pass at the sides of the nucleus without apparently being in contact, and unite again with the single fibre to continue their course. In such an arrangement, whatever may be the fact in the single grey nerve-fibres, I think we may justly conclude the single fibres here have to be composed in their whole course of two or more (Fig. 11).

In attempts to offer any explanation of the action of the fungiform papillæ, supposing them to be the chief seat of taste, it becomes necessary to try and settle the preliminary points of structure; but admitting these points are not fixed, still we may be at liberty, according to the view taken, to suggest the action of the various parts. Suppose a sapid body to be presented to the surface of the papillæ; that the substance percolates or dialyses between the outer cells which I have regarded as epithelial, and gets to the surface of the extremities of the cylinder rods or little tuft, and that a sensuous impression, of whatever nature it may be, is at once conveyed to and distributed through the plexus beneath, and by it to the divisional fibres of the dark-bordered nerves in the fungiform cone or expansion; by these conveyed to the centre, there to excite an impulse or sensation which is recognized; and by the sympathetic returned through the fine nucleated nerve-fibres given to the arteries and capilliaries, by which indirectly the secretion of the epithelial cells may be temporarily augmented, and a motor impulse conveyed to the muscles of the papilla itself; or to the muscles at the base of the tongue, palate, and the larynx, by which the act of swallowing is induced; and this to be repeated as often as the impression lasts, or is sufficient to disturb the harmonic balance,—may afford a faint picture of the actual condition.

The distinction and action of the several nerves under their

having employed the highest magnifying powers. The subject undoubtedly wants reinvestigation. My own opinions are embodied in this and a paper on Tipula crystallina, presented to the Royal Society last year.

ordinary conditions appear to remain pretty constant; and if we admit the necessity of a circuit, of whatever nature, between sensory, sentient, motor, and functional or ganglionic nerve-fibres as absolutely complete at all parts, though not equally apparent, we should expect an impulse made at any point felt throughout the rest: whether this impulse were made through the medium of intervening tissues, which might modify its abruptness, or made directly, if it could be effected without injury, on the nerves themselves, the difference being simply whether the impulse be firstly directed centripetally or centrifugally; hence, if we show the peripheral plexuses among the single nucleated efferent and afferent fibres and single fibres from the dark-bordered nerve-fibres to be very widely related amongst each other—in fact continuous, externally and internally—then we might expect an irritation made at any part of the body would influence the entire system; yet this scarcely appears the case in the ordinary condition: but suppose some trivial injury is received in a part distant from the centro-spinal centre, for a few days it may be almost unnoticed (though doubtless at the time of the injury the response in muscles, capillaries, &c., was duly made) until stiffness of the muscles of the neck and jaw, with other symptoms, indicate the peculiar irritability attendant on trismus, or lock-jaw; what then constitutes the difference between these two conditions? Here the exalted state of all parts of the surface and centre of the nervous system would tend to show their general connection; or we might take an opposite condition induced by syncope or cold. Whether then should we consider the whole nervous system as made up of an innumerable number of small circuits (Dr. Beale's continuous and constantly passing currents), each controlling the parts with which it is in immediate relation, by position or function, without interfering with adjoining parts, but capable of such individual exaltation as to pass beyond its own boundary by contiguity of tissue or by participation in the primary impression by virtue of its general exaltation—or whether we should regard the whole nervous system as one circuit, one primary circuit only, which begins with the life of the individual before any distinct nerve-substance can be detected, and which harmonizes the first circulation of the embryo chick, but which, under the power of growth, adds to itself through life; enlarging its stations, perfecting, exalting, or diminishing its powers; no portion of which could be impressed in any way without its effect passing to the complete system; but that without duration or primary intensity, the secondary transmission or distribution of the original impulse would not overcome the harmonic balance of normal relations, in other words, would not disturb its normal statical condition by induced currents,—is unsettled.

Thus we might add to or diminish the impressionability up to a certain point without any noticeable correspondence or recognition;

but once overcome the physiological resistance, and the influence, no longer restrained, determines complicated changes, requiring a longer or shorter time to return to the original state, or else may induce such molecular changes in its own condition as would result in pain, destruction, and death.

Again, whether the original impulse or nerve-force is changed in its character at the centre or the peripheric plexuses must be uncertain, until we learn the exact nature of the excitation; and until it is determined whether there be in the most delicate plexiform arrangements (Beale's fine plexus of pale-grey fibres), transpositions of impressions, or whether each fibre contain elements of each part of the circuit, preserving, though so closely contiguous, a distinct and definite channel of transmission,—we must be content with much that is conjecture.

If with Bidder, Volkmann, and others we assume the ganglionic system to be anatomically independent, we might regard the various associated ganglia and separate microscopic ganglia as so many augmenting sources for strengthening weakened currents or impulses, in the same way as relay batteries assist the weakened current of an ordinary galvanic arrangement; the impressions from which may be insufficient to give an intelligent signal at a very distant point, but sufficient to disturb such elements as shall give out their own dormant energy in the same direction as the original impulse; or in another view they may be as centres of independent action capable, under stress of work, of adding largely to the original energy derived from the cerebro-spinal ganglionic aggregate.

It may be asked, If all ganglion-cells be original sources of nervous energy, at what period of their growth do they assume their office; when are they said to be complete; and what are the microscopic appearances by which these points can be determined? Do circuits from other sources passing by or to them in their early stage, establish their course, or do they evolve it after a fixed manner? If these questions arise in reference to the larger germinal ganglionic microscopic bodies, what of the smaller nuclear ones? Are bipolar and multipolar processes or fibres from or to the little germinal nuclear body, sufficient to give it its physiological or functional value? Without allusion to the transmission of currents through caudate nerve-cells as centres of induced currents of distribution or of direction, as Dr. Beale suggests for their office, such questions, though difficult to satisfactorily answer, appear open for investigation.

In the fine nucleated nerve-fibres, I consider with others many of the nuclear bodies as something more than mere centres of germinal matter for the growth of the fibre, especially in cases where two or more fibres can be traced at one end or both, and believe they are to these fibres centres of nerve-influence in the form of relays; so that any impression of a delicate nature which may pos-

sibly be insufficient to induce beyond a certain extent the molecular change, supposed to belong to such an impulse, may excite in it a stimulus, which is at once added and propagated in the original direction.

The irregular character of the outline of the nerve-substance in the dark-bordered sensory nerves of the papilla, with their almost chain-like appearance, if natural, seems due to a want of union of the white substance in the intermediate links, and would, I think, lead to the supposition that the white substance does not play the part of insulating the axis-cylinder only; by dissolving out some of the fatty matter, many of the dark-bordered nerve-fibres retain very much the appearance of the fine nucleated nerves, whilst in others no such change is perceptible.

Modern discovery has largely advanced the knowledge of minute anatomy, yet its present state is insufficient for the demands of scientific exactitude. Much time and labour will be required to gather the facts already worked out by various observers, and bring their valuable contributions into a comprehensive concordance; while re-investigation, where needed, offers the most ready method of dealing with the difficult and abstruse points on which opinion is divided, —the quickest mode of correcting error, and determining the value of the conditions which underlie the best theories:—yet before existing analogy shall become identity, and the phases of such minute distinction be brought into harmony, we may conclude that the smouldering embers of controversy will lie many lines deeper.

II.—*The Relation of Microscopic Fungi to Great Pathological Processes, particularly the Process of Cholera.*

By J. L. W. Thudichum, M.D., &c., Professor of Pathological Chemistry in St. Thomas's Hospital.

(A Discourse delivered before the Royal Microscopical Society, *June* 10, 1868.)

Mr. President and Gentlemen,

I appear to-day before you without either specimen or diagram, and therefore depart from a practice which, as beneficial, has become almost universal in discussions of natural science, namely, that of demonstration. But I do so for a particular purpose, which I may indicate as my desire to restore thought to its right in relation to a particular subject. It has occurred in the matter under our consideration what a celebrated philosopher has warned against: stupid things put before the eye have a magical right; because they keep the senses prisoners, the spirit remains a

knave. By leaving the stupid things out of sight, I have therefore a chance to liberate the spirit and effect my object.

When I was requested to give a paper on the cholera fungus, I replied that I should be unable to admit a connection between fungi and cholera, and that my discourse must be critical. Let me add that it is my intention to make the critical part as short as possible, and that it will be my endeavour to gain some positive advantage out of a sketch of the researches on cholera, which it was my privilege to carry on in 1866 for the Medical Department of the Privy Council. It will then be easy to satisfy you that the Microscopical Society, as a body, might take some beneficial action with regard to the question of cholera even now, when the disease seems far off. I will then present you some general views, which will enable each of you to contribute his share to the work which will have to be done if the words Medicine, Pathology, or State-Medicine, are to be more than hollow sounds.

Cholera is at present a word which, if you mention it either to the readers of a scientific journal, or to practical physicians, or to ordinary people, generally excites a sense of tedium. It is only a year and five months since there was an epidemic in this very town of London which seized 20,000 people and killed 8000 among them. During the last four years there have died in Europe certainly not less than 200,000 people of this very disease. Many more have been ill from it, and the loss of life and health, of work, and in affairs which has been caused by it, is so enormous that I fear to present to my own mind any estimate of it. How is it possible then that such a plague can be looked upon with indifference by anybody who is concerned, or may be concerned any day, in the treatment, contemplation, or endurance of it? It is not easy to explain this fact; it has, at least, partly arisen from this, that theories have been made on it which had no or little foundation in fact and experience. The mere perusal of the hypotheses which have been ventured will convince you how impossible it is upon a small basis of experience to construct any merely probable theory of cholera. I shall convince you that although we have made a little progress, nevertheless further progress can be made only by studies upon a much larger scale than have hitherto been deemed necessary. I shall put before you that which has been achieved and that which has to be done, because, if it is to be done, it is you and those like you who are now engaged in scientific study who will have hereafter to achieve it.

We are now generally agreed that cholera is introduced into the human body by the mouth. We have a direct proof that cholera *can* be so introduced, from certain experiments which were first made at Munich in the year 1854. Professor Thiersch then happened to investigate the fœtal development of white mice; and

it then occurred to him to subject these animals to experimental infection. However ridiculous may appear experiments on white mice, the sequel will show how singularly fortunate was the accident which led him to employ these animals. He had some sixty white mice; and in order to trace the effects of cholera evacuations upon these animals in a reasonable way, and to imitate the probable conditions under which men might be infected, he dipped small pieces of blotting-paper, about an inch in width, into some cholera evacuation. The first paper he dipped on the first day; and the second paper he dipped on the second day into evacuation which had stood for one day, and so on; and in this way he obtained a series of slips dipped into the cholera evacuations on the first, second, third, fourth, and so on to the fifteenth day. Each cholera evacuation therefore yielded him fourteen or fifteen slips of paper. Each bit was soaked with an exceedingly small quantity of the matter contained in the evacuations. He then took a series of mice in cages, and which were all observed before and found healthy; and he gave to each mouse, or each couple of mice, two square inches of the paper which had been infected. The consequences were, that of the whole number of mice employed, a certain percentage became ill. They had bloody diarrhœa, or diarrhœa, and they became cold and refused to eat their food; and many of them died.

In the experiments which I made during the summer of 1866 in the pathological laboratory of St. Thomas's Hospital, the result was exactly the same as in the experiment of Thiersch. I had forty-eight mice in twenty-four cages. They were all infected in the same manner with cholera evacuations obtained from cholera patients, and the result was as follows. Some of the mice became affected with colourless or bloody diarrhœa, and loss of urinary secretion. They became cold. Their temperature sunk, so that the hand could feel the loss of heat.* Some became stiff so as to appear dead, while yet feebly living. They were positively stiff, so that the animals could not straighten their bodies or recover them from the position in which they were lying. There was in short a kind of cramp, just as in cholera cases. Some died in such position that it is probable that spasm was one of the ultimate symptoms. For instance, some died as if they were sitting before their food and eating it. This is a very unusual position for animals to die in, as during the agony they mostly fall on their side. The intestines of the dead mice were filled with whitish matter, and their abdomen was always expanded. Here you have then, a resemblance to human cholera which cannot escape consideration. Most of the animals

* An easy mode of measuring the temperature of a mouse is to put it into a narrow tube; it will then coil up, and a thermometer placed into the centre of the coil easily shows the heat of its body.

were pure albinos, that is to say, having no coloured hair whatever on the body, and perfectly unpigmented eyes. This is a circumstance to be remembered, as we are told in connection with experiments on the excision of the supra-renal capsules that albinos have a physiological economy differing in some respects besides the chemistry of pigment from that of other animals not albinos. Some pathologists are inclined not to attribute any importance to that statement and to doubt its purport; but I mention it in order that your view should be perfectly open to that point. It must, however, be noted that one of the mice which died was grey and white, but, as it was bred from albino stock by crossing with a rare variety of tame mice, it forms a singular exception to the fact that the animals employed were albinos.

I have a detailed statement concerning the animals experimented upon, but will only trouble you with the gross results.

Total number of animals	51
Total number of sick	13
Total number of deaths	11
Recovered	2
Not affected	38
	51

The observer is struck with the peculiarly small number of recovered animals, compared with the number which died. Eleven deaths out of thirteen sick, is a proportion which is very much greater than the mortality in men. In men ordinarily one half of those affected die. Most remarkable, however, is the circumstance that, out of the eleven deaths, ten occurred to pairs of which each were living in a cage together, and that these deaths of the individuals of each couple took place almost at the same time. This points to a very definite cause of disease,—a simultaneous introduction of its poison, and a great similarity in the manner in which animals susceptible of it reacted upon it. The cause of the immunity of other animals, apparently subject to the same influences, remains a secret, just as hidden as the cause of the immunity of many men in epidemic times. The majority of men in epidemic times are not affected by the disease, but only a small proportion; and this peculiar liability we cannot explain at present. We call the exemption of those who are not affected "the immunity," and the opposite "the liability"—a disposition or pre-disposition caused by the individuality, by the time, and by the place in which he lived. I recommend you to study the researches of Dr. J. B. Sanderson on the entire subject of cholera infection, and the very complete account of the literature of the subject which he has given in his Report to the Medical Officer of the Privy Council.

The evidence which I have laid before you is collateral, and not

direct. The direct evidence that fermented cholera stools produces the disease in man has not been furnished, but inferences entitle us with justice to assume that here, as in our experimental animals, the disease is produced by the introduction into the stomach of fermented cholera stool.

We have certain evidence of a negative nature which confirms the positive proposition that the cholera poison enters the human body by the mouth. Cholera is not inoculable. If you prick your hand while making a post-mortem examination, or if you cut it intentionally and put in a little of the matter—even the putrescent intestinal matter—you will not thereby produce cholera in yourself. If the body be putrid, you may produce a putrefactive inoculation just as from any ordinary anatomical subject, but you will not produce cholera. If you take the blood of a cholera patient and inject it into animals, you will not thereby produce any symptoms of cholera. The experiments by inoculation have been made, particularly by Russian physicians and surgeons—amongst them, Pirogoff.

Now, the next negative point regarding the transfer of cholera, is that it cannot be transferred by the breath. I have many a time bent over cholera patients to smell their breath, and have taken it into my lungs fully and long, and have never perceived any ill effect from it; and, in fact, the care which many persons, not only physicians, but others, have bestowed upon cholera patients shows that if certain precautions are observed, cholera is certainly not transplanted by the breath.

But by what means, then, is cholera transferred from one man to another? It is effected in this way: that the cholera patient discharges rice-water which is thrown either into a room, or into linen, or into a bed, or goes into a closet or privy, or upon a dung-heap, or is mixed with water and runs into the watercourses; and there the rice-water so distributed ferments, and after it has so fermented, a small particle of this fermented rice-water is transferred into the mouth and stomach of a healthy person. The evidence on that point is so convincing, and the instances which make it up are so numerous, that it is not necessary to repeat or multiply them. For instance, there is the great case which happened in Bavaria in 1854. There was there a male prison into which was admitted a man with cholera, and he infected eight or ten others, and the whole of the dirty soiled linen of those persons was sent with the other linen several miles off to a female prison to be washed. There had been no other introduction of any kind into that female prison, but a great proportion of the washerwomen who washed this choleraic linen were affected with cholera, and distributed it immediately in the female prison. Instances of that kind tell their own tale. I do not say that cholera is exclusively so distributed: there may be other means. But we assume that that which

is positive contains the entire truth, until we see that there are other facts to be included. You see that in following the migration of the cholera poison, I am contemplating events which admit of chemical consideration. I shall afterwards show you that cholera evacuation or rice-water is a particular fluid which has no equal in any other fluid as regards the kind and rapidity of its decomposition; that during decomposition it undergoes changes which are also of a specific kind; and that this fluid so changed reproduces the entire process. In addition to the direct poison, there must be certain favouring circumstances before cholera can be developed. Among these is impure drinking-water. We have the epidemics of the year 1848–9 here in London; 1854–5 also in London; and again the epidemic of 1866 in Whitechapel. In all these it has been clearly proved that a population which drinks impure water, or water containing a very large amount of putrescible or putrescent organic matter, is twice or three times as liable to be infected with cholera as a population drinking pure water; and not only that, but if a population is thus affected with cholera and drinks impure water, its mortality is twice or three times as great as the mortality in any other choleraic epidemic which occurs in a place in which the people drink pure water. You can take these facts as axioms; but do not therefore venture upon the conclusion that in every case of cholera it has been the drinking-water which has caused the predisposition. There may be others of which we are not yet aware, and which we have to study; but where we find those facts so well proved as they have been here in London, we have a certain right to assume that this was the main predisposing cause.

We find impure air to be a means of the distribution of cholera, and an element of predisposition. What is there easier than that in the house of a poor person a quantity of vomit from a cholera patient should go behind the bed, along the wall, and make a little pool in a crevice of the floor where it is not wiped up? It is not disinfected; it stands there and putrefies, the more easily as these alkaline matters have a peculiar hygroscopic power, which enables them to attract water in sufficient quantity to resume their decomposition even after they have been apparently quite dried. The bed is afterwards moved by other people; a dust is raised, and with that dust a small particle of the dried substance is carried up, and the consequence is that a person who before was not affected, now breathes that dust and gets it into the mouth, swallows it, and becomes affected by cholera. Thus, the impure air and the dust of the house become carrying and predisposing agents for the propagation of cholera.

The consideration of impure food will lead you to the same result. If persons eat with dirty hands, and are in the neighbourhood of cholera patients, or of impurities such as I have now

described, what is more likely than that a small quantity of choleraic matter should get attached to the hands, and be introduced with the food into the mouth?

Now it is found that if the ordinary rules of hygiene are observed, there is an absolute immunity from infection among those who are with the cholera patients and come into the closest contact with them. They may rub and wash them, attend to them, dissect their bodies, or analyze them chemically as we have done, without the least evil consequences. During the epidemic of 1866, wherever special modes were employed to avoid those ordinary known and supposed means of introduction, we did not observe one instance in which the active cholera poison was actually introduced into a person so employed.

Every kind of rashness and excess predisposes persons to cholera. No doubt poverty and bad living, engendering as they do dirt, irregular hours, and excess, are important aids in the production of the chemical process of which we shall have to speak.

I put it down then as a thesis to be derived from what I have laid before you, and one which I do not think will be controverted in the present state of affairs, *that the infectious matter by which cholera propagates is the fermented cholera excrement.*

"Rice-water" stool is a term which owes its origin to the similarity of the evacuation to a decoction of rice. It is a very white fluid, almost milky in some cases, and there is suspended in it a greyish-white flocculent matter, like the peculiar starch of rice which is detached from it by boiling. If you take this rice-water and test its reaction, you find it strongly alkaline. It has not a very great fecal odour, but sometimes a remarkably putrescent smell; and immediately it is out of the body it continues the process of decomposition to which it had before been subject. Rice-water contains a derivate of the substance which we call mucine, the basis of mucus. Mucine is distinguished by its being precipitated by acetic acid, by its being dissolved in alkalies, and swollen up to those masses which you know as the means by which the human body lubricates all the surfaces of its cavities and exits. Amongst various interesting other properties is this, that on decomposition with hydrochloric acid it yields sugar. Other derivates contained in the rice-water are those of albumen, besides albumen itself. You know that in certain decomposition processes albumen yields butyric and acetic acid. Those acids are found in the cholera-stool shortly after its expulsion.

We further find dissolved in the cholera-stool a small quantity of decomposed blood, altered in such a manner that its spectrum differs from that of ordinary hemato-crystalline; the absorption-bands are very similar, but the alpha band of the cholera-stool is rather narrower than the analogous band of the blood, and the

second, or beta, band is somewhat broader. This is not hemato-crystalline in the ordinary form. Measurements show that there is a difference, which is of importance when we consider the many products of decomposition which the blood yields.

There is another singular body contained in rice-water, the presence of which can only be shown by indirect means, rhodofluine. Upon treatment with nitric acid this body assumes a splendid pink colour, and then is powerfully fluorescent. That is an important property to bear in mind, because we are at present not acquainted with any other substance which yields that reaction. Possibly it may be also a derivate from the hematocrystalline. At all events this substance is the most specific, perhaps the only specific, one contained in rice-water.

We further have ammonia and compound alkalies which, in the place of one or all of the atoms of hydrogen contained in ammonia, contain a compound radicle. Amongst them probably is trimethylamine and monomethylamine; and also, possibly, more complicated amines with higher radicles.

The animals which occur in the cholera-stool are called by microscopists "vibriones." They have nothing specific. If you allow any animal matter to putrefy, such as urine or meat, in water, you will find numbers of vibriones. They are excessively small, and require high powers of the microscope to be seen; but when you have them under high powers, you can see them move about, and put their heads against the glass and flatten them off. They have apparently no internal structure. They are properly called *vibriones*, because they vibrate or oscillate to and fro without necessarily changing their place. I have observed the mode in which they multiply,—it is by division, in the manner in which many animals of the worm tribe and of other lower types of animals multiply. The vibrio moves its body incessantly to and fro, just as the *naids*, and then it begins to make a division near the middle. It gets narrower, and acquires a waist, and presently it is divided, and you have two vibriones. This multiplication takes place so rapidly, that in urine which is sufficiently dilute, you will find innumerable individuals produced in twenty-four hours from one single vibrio.

You find another important ingredient in the cholera-stool, namely, epithelium cells of the intestinal canal. You know that, for the most part, that canal is so constructed that it possesses a great many projections of the form of little microscopical fingers, which are called *villi*. Of these villi there are about ten millions in the intestinal canal of man. Each of these is covered with a film of cylindrical cells, which when seen in section have in their body a cylindrical shape, but at the end becoming more conical.

Now what occurs in cholera is this—that from many of these

villi the epithelium is cast off, partly in entire coverings like unto the finger of a glove pulled off the finger. In other cases the cells come off singly, and then you find under the microscope cylindrical or conical single cells, each provided with a nucleus. There are also other cells from the mouth, particularly the tongue, from the gullet, the stomach, and from the rectum, which are round and have a nucleus.

Now all those inquirers who in former years examined cholera evacuations and found those cells, perceived that they were in a particular state, differing from the ordinary healthy state. They were covered with granules, and their margins were somewhat indistinct. This granular condition of the cells has been called "granular disintegration," because while the granules are on the cells the latter expand and lose their outline; ultimately many of these cells fuse into a heap of granules, without leaving any outline or nucleus. In fact the alkaline rice-water corrodes and swells up the cells and breaks up their substance and nuclei in the same manner as caustic alkalies do, when left in contact with them under similar circumstances.

But what has been the explanation which has latterly been put upon that circumstance? It has been stated that these granules sitting upon these cells are the sporules of a particular fungus, which has been called the "cholera fungus," and the theory of cholera has been based upon this in so far that it has been said: Cholera is a parasitical disease arising from the introduction into the body of the sporules of a fungus which have the power of multiplying, and by their multiplication destroying the epithelium upon which they feed. By one observer this granular matter has been termed "micrococcus." Here it is well to make a deliberate digression on terms, in order that our discussions of facts and allegations may not suffer any detriment from the want of intelligibility of new words and the absence of precise definitions. Coccus is the Greek word, with a Latin ending, for kernel or grain. The prefix of "micro" produces a compound word, which signifies small grain or "granule." This latter word is current, and everybody understands it. We know that most microscopic observers have seen granules on cells from the cholera intestine. It follows therefore that the term "micrococcus" implies no new discovery, but is only a new term for a feature long since and often observed. Its only claim to existence is the new interpretation attached to the granules, which are claimed to be sporules of a newly-discovered fungus.

Other observers having seen that these granules were imbedded in mucus, have attached to them a somewhat different interpretation. If, in order to become acquainted with the theories of cholera of the present day, you study the discussions which took place last

year, at the meeting of savants which has been termed the Weimar Cholera Congress, you will find a report in which the reporter of the Committee which had been appointed for the task states that they had examined cells from choleraic intestines, and found them covered by a mucous matter, in which many granules were imbedded; that they believed these granules to be a kind of *alga* living in gelatine, produced by its own vital action (as many algæ actually do) and to this formation they gave the name of "*Zoogloea.*" The Greek word "γλοία" in modernized language becomes "gloea," and means glue, gelatine, or mucus. This word therefore does not imply a new discovery any more than micrococcus. The granules imbedded in mucus are only newly interpreted thereby to be algæ imbedded in their own, a self-made gelatine.

Thus far all observers are agreed regarding what is visible on desquamated cells from cholera intestines, although they all differ regarding the interpretation to be put upon the data. But now begin discrepancies of fact and argument, which are highly characteristic of the nature of the method by which the inquiry is conducted. The Weimar reporter (De Bary, a botanist, and considered an authority in fungology, on which he has published a learned and voluminous treatise) says, that no one had a right to assume that these algæ of the zoogloea developed themselves into a fungus, unless he had with his eyes witnessed the transformation directly under the microscope. This opinion is very prudent, and manifests the true philosopher. Another inquirer (Klob of Vienna) is much less cautious. He found the granules, termed them spores, and stated that they regularly grew to be fungi, of the filiform, jointed kind, to which he gave the name of "cylindro-tænium." At the time of the first flush of the supposed discovery, all these formations were to have been specific to cholera only. But Klob has since found them to be present in evacuations from persons who were suffering from diseases having nothing in common with cholera. The doctrines of the Vienna inquirer are thus in course of being let down easy, and as they moreover fail to satisfy the demand of the Weimar reporter above given, require no further comment from me.

The discoverer of the micrococcus, Hallier, Professor of Botany at Jena, has gone farther than any other writer, and has given to his ideas so decided a form, that he has entitled his pamphlet containing their exposition abruptly, 'The Cholera Contagium,' as if he had actually found and settled it. And how do you think he has made his discovery? The professor sent or wrote for some cholera evacuation from Elberfeld, and some bottles were filled with it, stoppered and sent to him to Jena. Another bottle which had been kept filled and corked for more than six months was sent to him from Berlin. He allowed those bottles to stand upside down

until sufficient matter was deposited on the cork; this heavy matter he allowed to drop out after having loosened the cork, and examined it under the microscope. It contained the fruits or seed-capsules of fungi.

If you want to have a few days' instructive amusement, I advise you to get yourselves a book on the structure and transformations of fungi; and when you have read that book you will be a great deal wiser than you are at present, and be more particularly in a position to judge of propositions of pathology made by fungological botanists. The method which botanists employ to investigate the development of fungi is, that they sow the sporules, if they can isolate them, on a medium on which they think they will thrive. They produce a mould, and they examine the various stages of growth in that mould, the fructification of it, and so forth, and then they take upon themselves to say: These sporules, these fungi, these fruits, and so forth belong to one plant, and are various stages of one plant. This method has given rise to great controversies among botanists, which are not decided yet, and to which I would not dare to introduce you. But of course it was applied by Hallier to the "micrococcus" and the "seed-capsules" (capsules filled with micrococcus) of the cholera-stool.

The professor put his sporules and seeds *as far as he could isolate them* into flasks containing various ingredients—sugar-water, paste, meat, &c. Of course it is reiterated in the account that precautions were observed to prevent the introduction of all foreign vegetable germs, and that the flasks were steamed, so that all naturally contained spores should be dead before the cholera-germs were introduced. When that, however, had been done, the growth of the cholera-fungus commenced. It would be impossible for me to lead you through the labyrinth of terms with which the professor studs his bewildering description. I will give you a few as an example. The "micrococcus" passes partly into "torula," partly into "cryptococcus," and forms a "mycoderma." The "torula" passes into "oidium lactis," when one is quite relieved, to be sunk all the lower by the announcement that this "oidium lactis" is nothing else but the "cylindro-tænium choleræ asiaticæ" of Thomé. This belongs to the species "Penicillium," "Mucor," "Achlya," "Tilletia." The "oidium" forms the "macronidia,"* which are the organs producing by germination the "mucor-plant." Amongst the "micrococcus" there occurs also "arthrococcus" and the ubiquitous and obliging chains of "leptothrix." All these forms lead to the discovery of a fungus of the "ustilagineæ" tribe, with a tender "mycelium" and cystlike fruits. These latter determine the species to be "urocystis." A plate represents the appearances of most of the stages of its mysterious development.

* *Query:* Macroconidia?

Enough: the author of this pamphlet presumes that the audience whom he addresses are accomplished fungologists. This is really asking a little too much, seeing the confusion in which fungology is at present. Even at the scientific meeting at Frankfort, in autumn, 1867, it was shown to be a very chaos. Nevertheless, I have been patient, and worked my way through the doctrine with dictionaries, handbooks, and the usual aids of learning, but it is hardly necessary to go to that trouble. The experiment lapses entirely on one point, to which I draw your attention. When Hallier took out of his bottle a small quantity of matter, containing the "micrococcus" and "urocystis," and put them into his steamed apparatus, he had no security whatever that there were not thousands of other sporules contained in the mixture and passed into his apparatus.

If I eat a piece of green Stilton cheese, I swallow millions of sporules. There are hundreds of things—for instance, sour milk, bread which has stood for some time, and meat which does not even smell—which are positively penetrated by fungi of various kinds. If you drink a glass of beer you swallow thousands of sporules of the particular kind which form the fermentum or the fungus cerevisiæ. Indeed all decomposing matters contain vast numbers of sporules of various fungi; and therefore to presume that in that drop of matter which he put into the bottle, he had brought in nothing but the particular cells constituting the cholera fungus, is one of the most patent errors that a man could commit.

The doctrine has not been wanting the support of warmed-up old fallacies. Hallier said that his fungus required a certain warm temperature, and that in the cold it did not grow. Hence he argued that it must come from a warm climate. Cholera comes from India. You see at a glance the vicious round of conclusions. The fact that "cholera comes from India" suggested the inquiry, "How does it come from India?" There was an old hypothesis of an author of the name of Tytler, who in the year 1833 wrote a "sensation" book on the "Morbus oryzeus," or rice disease, *alias* cholera. In it he propounded that cholera was diffused by means of rice. There is nothing more absurd than the idea that a fungus could be introduced into the human body by rice, which can never be eaten except when boiled, and which is never either by man or animals put into the mouth except after being thoroughly cooked. Most absurd was this hypothesis, but it was nevertheless accepted for a time, and the cholera was called after it. This barren hypothesis of the year 1833 now in 1867 was made to serve as another support to this fungus theory: "The fungus lives in rice, it is propagated in and by rice; and I will show you how," said M. Hallier. He put earth into a flowerpot, sowed rice into it, and manured it with cholera excrement; and to his very great

satisfaction the "cholera fungus" penetrated the seed corns of rice, and the young radicles.

I showed you where the first lapse in the doctrine occurred, namely, in the introduction of the so-called "sporules" supposed to be contained in rice-water into the so-called "cultivation apparatus;" but the second lapse is still more important and evident, for, supposing the *presence* of the fungus is allowed and established, it is not yet shown what is the connection of this fungus with the disease. How can you prove that this fungus actually destroys the epithelium, and does not merely live upon the products of the changes, as so many saprophytes do, which thrive in putrescent animal matter? Here, therefore, you are quite at liberty to conclude the alternative you please, and no necessity has been shown for us to assume that, supposing a specific fungus were actually there, it caused the destruction and was not merely living accidentally upon its products.*

I believe I have fairly exhausted the main special arguments on this subject; but I will look upon it for a moment in its general bearings. I will ask you to answer a question, and after that I will answer it in my own sense. I ask you, do you think it likely that a botanist situated at Jena with some bottles of cholera excretion—four obtained from Elberfeld, and one more than six months in bottle from Berlin—could, at one stroke, with one glance of his eye, discover the cholera contagion under the microscope? I ask you as microscopists whether that is probable? Now I tell you my own opinion on the subject. If it were possible that a botanical professor could make such a discovery, and it could be well established, I, as a medical man, would to-day abdicate my functions. I would at once retire from the medical profession. I would lay down the serpent and staff, which would have lost their ancient dignity. I would say that I had been a very great impostor to mankind; that I had pretended to possess a certain method of gaining knowledge which I did not possess; that I had been pretending to inquire into some of the deepest problems, and failed to find anything, while a botanical professor had been capable, by a simple scrutiny with the aid of the microscope, to discover that which I had been searching for with all my might for years and years. I should under those circumstances rather become a drawer of water and a hewer of

* At the meeting of German savants at Dresden in September last, Prof. Hallier delivered a discourse on sixteen varieties of fungi, which he claimed to be specific to as many different diseases. But he took entirely new ground by admitting that as yet no connection of these fungi with the diseased products in which they occurred had been proved. Perhaps the reader will think that the professor thereby removed the ground from under the question altogether. The fungus of variola has now become identical with a fungus common on grass. The "urocystis intestinalis," which was to have been a specific inhabitant of the intestine of persons suffering from diphtheria, does not differ from the "urocystis occulta" on grain.

wood, and clothe myself in sackcloth and put ashes on my head than any longer bear the shame and degradation which would fall upon me if such an event were possible. But if the reverse be the case; if this fungus theory be not true; if it be, as I pronounce it to be, another of those fallacies with which the subject, not only of cholera but of other diseases, has been surrounded; if the view which I am proposing to you now is more correct than the other views which have been proposed, then, Gentlemen, I claim for myself the merit of having, in times when pathologists did not dare to pronounce an opinion, ventured to pronounce mine, and of not having carried on two shoulders. At the meeting of the German Association of Physicians at Frankfort, in September, 1867, Professor Virchow mounted the tribune, and in an oration in which he professed to describe the progress which pathology had made in recent times, stated that he had not had an opportunity of making up his mind on the subject of the cholera fungus. And yet he had lived in the town of Berlin, where thousands of cases of cholera of the most severe type had shortly before occurred. Other pathologists have observed a similar bearing towards the new doctrine. But this slowness of supposed leaders has not prevented the practical men of our profession to form their own conclusions. I have spoken to many practical men, and all of them have shaken their head at the fungus theory, and none of them have allowed it to be of such a nature as to bespeak their confidence. Therefore we may dismiss it, and we will continue our own path and our own studies, from which we hope to establish better results than those arising from any previous hypotheses or investigations.

III.—*Heliostat for Photomicrography.* By R. L. Maddox, M.D.

(Plate II.)

The accompanying valuable communication (page 29) on a cheap form of heliostat, has been lately forwarded to me and offered for publication in the Journal of the Royal Microscopical Society, by Lieut.-Colonel J. J. Woodward, M.D., Army Medical Department, Washington, U. S. To it I venture to prefix the plan adopted by myself, as it differs in a few minor particulars to suit the position in which it has to be placed.

Mr. Rutherford's arrangement, as now modified by Brevet-Major Dr. Curtis, appears exceedingly perfect.

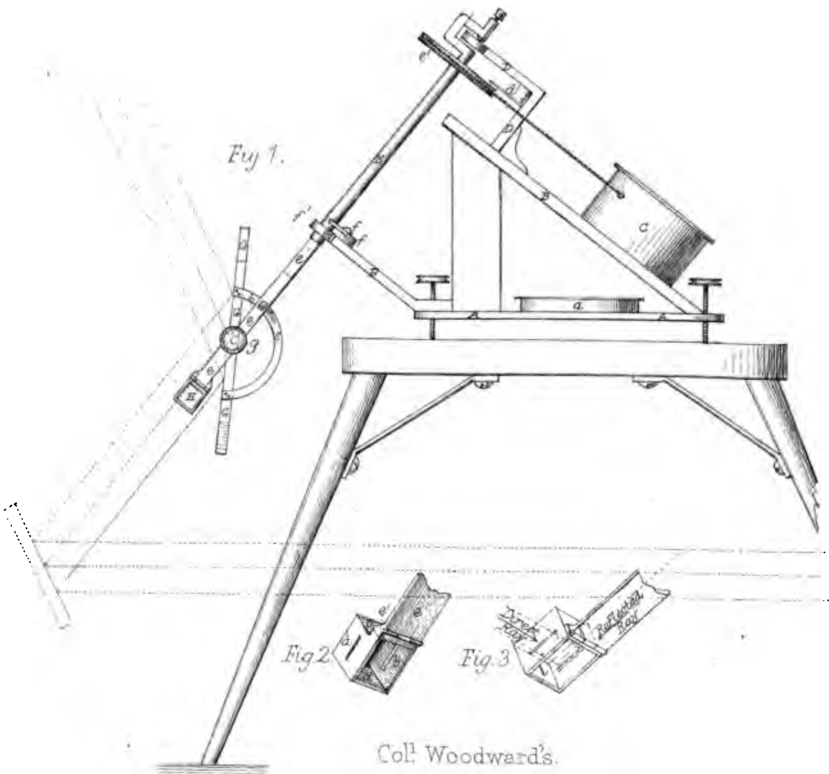
In 1867, Professor Laurence W. Smith, Kenyon College, America, when in England, showed me a drawing of a form he had adopted which was very simple in its construction, and later, furnished me with full particulars. The base or support being in the form of a long cross set in the direction of the meridian of the

place, did not suit well for my narrow window-ledge, facing S.W., at which it had to be used, but led to the plan of stand noted in the accompanying sketch, which is firm and portable. To this arrangement I have since appended the little cubic box as given by Dr. Curtis, it being easier to set than the four pointers I had originally adopted.

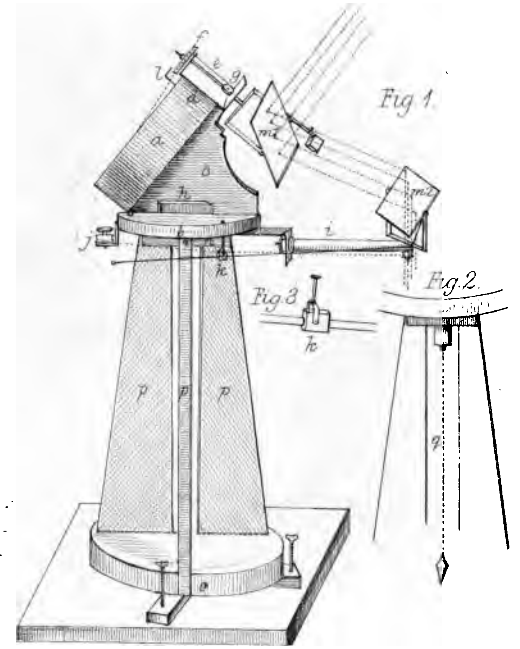
The arm carrying the second mirror *m* 2 was at first attached to the firm upright piece at the shutter end of the camera baseboard, but from the length needed, 20 inches, to give the light reflected from the first mirror the necessary horizontal direction, centrally with the microscope, it was liable to vibration under a gentle wind; hence it has been much shortened and fixed to the under-surface of the circular base, *b*. The clockwork of an American clock is removed from its case and set in a rectangular block of teak,* united at its lower end by a hinge-joint to the upper surface of a stout circular base, *b*, which carries a short central pin, Fig. 2, from which is suspended a bob or plumb line. The back of the clock reclines against and is fastened to one surface of a block, *c*, cut to the angle of the latitude of the place and fixed over the central line of the circular base. On the upper part of the clock-case is screwed a stout brass plate, *d*, turned up sharply each end at right angles, and pierced with two centrally opposite apertures, through which passes the rod, *e*, carrying at its upper part a grooved wheel, *f*, divided into 24 divisions 12 and 12, and subdivided into quarters, and at its lower end the crutch which holds the mirror *m* 1, one side being prolonged to carry the little cubic box, as suggested by Dr. Curtis, which rotates on a clamping pin. These parts are supported by two friction rollers, *g*, resting by their bevel edges on the lower plate of the doubly right-angled piece of stout brass plate, and turn easily by an endless band carried over the wheel *f*, and a wheel half the size, fixed on the arbor of the hour-hand of the clock. On the upper surface of the circular base *b* is fixed a square compass box *h*; from the lower surface of *b*, beneath the mirror *m* 1, is screwed a stout plate bent at a right angle, and slotted to allow, by clamping, of exact adjustment of the arm *i*, that carries the mirror *m* 2, the arm being pierced at the farthest end to admit the central pin of the mirror-crutch or support which, passing through it, is beneath provided with a wheel and an endless band carried over a second wheel with a milled head, *j*, fitted for rotation at the opposite side of *b*. By these the mirror, *m* 2, rotates in the horizontal plane.

From the under-surface of *b* hangs a short stem with crutch and block, *k* and Fig. 3, through which runs a steel rod, attached at one end to a lever arm connected with the mirror, by it a vertical motion is obtained. A small index point is fitted at *l*. This completes the heliostat proper, which, for use, is fixed by the central pin

* A brass box is preferable, or one made of zinc.



Col. Woodward's.



Dr Maddox's.

Curtis & Dr. Maddox del. Tuffen West sc.

W. West imp.

Heliostats

passing through a circular hole in the centre of the square block *n*, that forms the top of the column or pedestal, it being connected to the foot, *o*, by four uprights, *p*, *p*, *p*, set a little apart, in which space hangs the plumb-line (Fig. 2) *q*, leveling being effected by three screws on the feet of the support. This pedestal, although 14 inches high, has to be placed on a stool set on the window-ledge and cut to its bevel; when put in position, about a quarter of an inch of free space remains between the clock-case and the under-edge of the top window sash. If made of two parts only, it would have been less easy to get in position.

The hand is passed through a sliding frame in the shutter to set the angle of the second mirror by the milled head and rod, which is less convenient than the method adopted by Dr. Curtis, of two rods working through apertures in the shutter and handled from within; but in my case the shutter exposing a very large surface, it was found preferable to have the heliostat entirely disconnected.

The loss of light occasioned by the employment of a second silvered surface, I find to be *about* in the proportion of 3 to 2, or to require 33 seconds' exposure, when 22 sufficed with a single mirror. These periods would doubtless be much reduced by using mirrors silvered on the upper surface.

IV.—*Heliostat for Photomicrography.* By Lieut.-Col. J. J. Woodward, M.D., U.S., Army Medical Department, Washington.

This heliostat is designed to throw a steady beam of sunlight in the direction of the south pole of the heavens. It consists essentially of a mirror, adjustable perpendicularly according to the declination of the sun, and attached to the south end of a rod set parallel to the axis of the earth. This rod is then rotated at the rate of one revolution in twenty-four hours, by having a wheel fixed upon it, which is connected by a band with the arbor of the hour-hand of an ordinary clock.

Fig. 1 represents a side-view of the instrument. A is a triangular base-board mounted on three levelling screws, and furnished with a compass, *a*; B is a triangular plate of metal or wood, which supports the clock C and the right-angled arm D for carrying the polar rod E. This plate, B, is immovably fixed upon the base-board A, so as to make with it an angle which is the complement of the angle representing the latitude of the place where the heliostat is to be used. The polar rod E, which carries the mirror, is crank-shaped at the upper end, and rests by a pointed centre upon a depression in the bearing *d*, at the end of the fixed arm D. It is supported below by resting against two friction rollers, *ff*, attached

to the extremity of the arm F, and is prevented from slipping from its position upon these rollers by being embraced by the loose collar f', also fixed upon the end of the arm F. This rod D must make an accurate right angle with the plate B. It terminates below in a crutch-shaped arm, e, seen in the drawing in profile, which supports the mirror G at the sides, allowing it thus perpendicular motion for adjustment for declination. The mirror may be clamped in any position by means of the screw g. The rotation of the rod E is effected by a band which connects a wheel on the arbor of the hour-hand of the clock with the fixed wheel e', made twice the diameter of the wheel of the arbor, so as to perform one revolution to the latter's two, and therefore to turn itself once in twenty-four hours.

The adjustment of the heliostat for time of day and declination of the sun is most easily effected by the following means:—One arm of the crutch-shaped support e of the mirror is prolonged beyond the edge of the latter, and has attached to its extremity by a hinge a small cubic box, H, and which projects over the surface of the mirror, and is open only on the side represented in the drawing as facing the observer. Fig. 2 gives a perspective view of this box; e shows the arm of the mirror-support to which it is hinged, furnished with a projecting knee, e', to prevent the box from turning too far back upon the hinge. In the face of the box a, which fronts to the sun, is a fine slot, running exactly north and south, and upon the under-face b is a corresponding slot or line. Then to set the heliostat for time, it is only necessary to rotate the polar rod until the fine ray of sunlight passing through the slot in the face a falls exactly on the line on the under-face b. In similar manner the face c, which is turned toward the surface of the mirror, has a fine slot cut through it in a direction at right angles to that of the other slot, and upon the opposing surface d is a corresponding slot or line. Since these two slots lie in the direction of the polar axis, it is only necessary in order to set the mirror for declination, to turn it until the reflected beam from its surface which passes through the slot in the face c falls exactly upon the indicator slot in the face d. After the adjustments are made, the little box may be turned up on its hinge so as to rest against the supporting arm e, and leave the reflected beam from the mirror unobstructed. Fig. 3 shows in dotted lines the directions of the direct and reflected rays of the sun when the adjustments are corrected.

If desired, the wheel e' may have a dial-plate on its upper surface, divided into twenty-four hours, and numbered from twelve above to twelve below, for the purpose of setting the instrument for time. d' in the drawing represents an indicator for reading the time on the plate attached to the arm D. A graduated arc attached to the edge of the mirror-frame may in like manner be used to

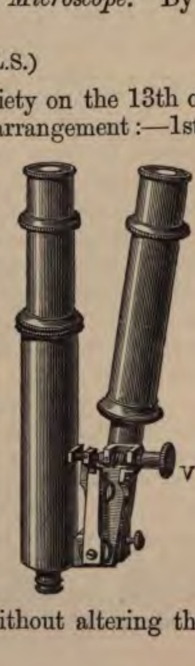
obtain the adjustment for declination. Such an arc is represented in the drawing, and if used, should be graduated as follows:—The indicator being a line drawn on the edge of a fenestrated opening in the arm *e*, the zero line on the arc should be taken at 45° from the diameter of the arc which passes through the plane of the mirror's surface. Then graduate the arc into half-degrees for 24 half-degrees to each side of the zero line; number each half-degree 1, 2, &c., counting each way from the zero line. Then each half-degree to the left or right of the zero line gives the necessary adjustment of the mirror for each whole degree of the sun's declination north or south respectively. To make the adjustment therefore, turn the mirror until the indicator points to the number of the graduations on the arc which represents the actual degree of declination of the sun for the given day.

In the drawing the heliostat is represented standing upon a stool on the outside window-ledge of a window having a south exposure, and the dotted lines show the direction of the sun's rays reflected from the heliostat mirror upon a secondary mirror, and thence horizontally into the room. This secondary mirror may be conveniently mounted on a rod fixed in the window-shutter.

V.—*On some Modifications of the Binocular Microscope.* By M. Nachet, of Paris.

(Communicated by Henry Lee, F.L.S.)

At the meeting of the Royal Microscopical Society on the 13th of May last, Mr. Heisch objected to my binocular arrangement:—1st, that it had the effect of modifying the focal distance of the movable body (or tube); 2ndly, that the fittings for carrying the prism and the body are liable to become loose by wear. Since last year I have remedied both these defects by a new arrangement, which is represented in the accompanying drawing. By this plan the angle of the tubes changes by the action of the screw V, and consequently the distance of the eye-pieces is very easily adjusted. The screw V has two threads of different speeds, so that the inclination given to the prism itself is half the displacement of the tube. This arrangement is necessitated by the fact that the displacement of the rays reflected by a rotating surface is double the angle described by this surface. The solidity of this apparatus is absolute, and the



proper distance for the eyes may be obtained without altering the

magnifying power of the two bodies. At the meeting above referred to, Mr. Heisch criticized the form of the central prism. I have abandoned that indicated by Mr. Heisch, because the vertical surface of the rectangular prism being parallel to the central pencil, a certain part of the light is reflected by this surface, and produces a kind of fog over the image. I have convinced myself of the perfect harmlessness of a parallel plate of glass placed in the direction of the image. In conclusion, Mr. Heisch mentioned the fact that many persons had used the new form with more ease than the remarkable arrangement of Mr. Wenham. The cause is to be found in this physiological fact;—that there is a certain difficulty in combining the strongly convergent images of the Wenham binocular, and also, as a second source of uneasiness, that an apparent diminution of the size of the image results from the great convergence of the pencils. It is therefore to be desired that all binocular arrangements should be less convergent.

VI.—*On the Vital Functions of the Deep-sea Protozoa.*

By G. C. Wallich, M.D., F.L.S.

The confirmation which my views regarding the presence of animal life, and the existence of an abundantly distributed fauna at vast depths in the ocean, have received, through the recent researches of Dr. Carpenter and Professor Wyville Thompson, affords a fitting opportunity for reviewing the state of our knowledge of such vital phenomena as are involved in the nutrition of the abyssal Protozoa, and of determining how far such phenomena are reconcileable with preconceived notions which prevail regarding the conditions under which alone their existence can be sustained.

In order to place the question in an intelligible light, it is necessary to call attention to the assumed law which presupposes that animal existence cannot be sustained without the previous manifestation of vegetable life; and to point out why this law cannot be regarded as valid in the case of organisms inhabiting the depths of the ocean.

It has been very generally laid down by physiologists, as indicating the line of demarcation between the lower portions of the animal and vegetable kingdoms, that, whereas the animal receives, into a cavity within its body, organic compounds already formed which it converts into nutriment, the vegetable lives upon inorganic elements which it imbibes through its external surfaces only. And, doubtless, this definition holds good as regards those Protozoa in which the differentiation of the sarcode has arrived at a certain limit. It shall be my endeavour. however, to show that in the case

of the Foraminifera—which are by far the most largely represented organisms at the bed of the ocean, in point of number, if not the most largely represented on the face of the entire earth, and which do not belong to the most, but to the least, highly differentiated group of the Rhizopods—nutrition is not derived from organic compounds already formed, but from inorganic elements present in the medium by which they are surrounded.

But we must retrace our steps in order to substantiate this view; and the first requirement is to show, not only that the condition as to the previous existence of vegetable life is absent, but that the condition, under which alone vegetable life itself could be maintained, is likewise absent.*

The vegetable draws its nourishment, according to Dr. Carpenter,† "from water, carbonic acid, and ammonia, and is distinguished by its power of liberating oxygen, through the decomposition of carbonic acid, *under the influence of sunlight.*" Now, whether we regard the undoubted absence of all vegetable forms, in a living state, from the deep-sea bed as consequent on the absence of light,‡ or merely as an attendant condition, it is manifest that the moment we have to deal with the lowest type of life in the abysses of the ocean, we must seek for some other mode of explaining how nutrition is effected. For, *a priori*, such lowest type cannot be referred to the vegetable kingdom; and if claimed as neutral, the arena of discussion may undoubtedly be thrown back a step further, but the real difficulty to be overcome remains as great as before.

These observations, although originally designed to meet the case of the known deep-sea Rhizopods, are now brought forward with a view to show that, even if we admit the existence of the widely-pervading "*urschleim*" which Professor Huxley describes in the last number of the 'Quarterly Journal of Microscopical Science,'§ we should not make any advance towards the solution of the problem of primordial life, and embarrass ourselves with a fruitless attempt to make its vital functions amenable to the law which can only be strictly applied to organisms of a more complex order. The grounds on which I seek to establish this view will become apparent as I proceed.

* Although these questions have been fully discussed by me, at p. 95 *et postea* of my 'North Atlantic Sea Bed,' published in 1862, it is necessary to revert to them in order to show their bearing on the view which has been recently propounded regarding the existence of a universally distributed deep-sea protoplasm, to which the name of *Bathybius* has been given by Professor Huxley ('Quarterly Journal of Microscopical Science,' October, 1868).

† Carpenter, on 'The Microscope,' 1856, p. 263.

‡ One of the most important inquiries in connection with the question of life at great depths is that touching the penetration of the chemical rays of light; and it will doubtless be another of the achievements of Photography to solve it.

§ "On some Organisms from Great Depths in the North Atlantic," 'Quarterly Journal of Microscopical Science,' for October, 1868, p. 210.

Professor Huxley, speaking of the "stickiness" of the deep-sea mud, says it "contains innumerable lumps of a transparent gelatinous substance. These lumps are of all sizes (* * *). When one of these is submitted to microscopical analysis it exhibits, imbedded in a transparent, colourless, and structureless matrix, *granules, coccoliths*, and foreign bodies." Again, after declaring the importance of keeping the questions of fact arising out of such an inquiry apart from questions of interpretation, he proceeds to inform us that he "conceives the granule-heaps, and the transparent gelatinous matter in which they are imbedded, represent masses of protoplasm." To these masses of protoplasm he "proposes to give the name of *Bathybius;*" and he adds—"From the manner in which the youngest *Discolithi* and *Cyatholithi* are found imbedded among the granules; from the resemblance of the youngest forms of *Discolithi* and the smallest *corpuscules* of *Cyatholithus* to the granules; *and from the absence of any evident means of maintaining an independent existence in either*," he is led to believe "that they are not independent organisms, but that they stand in the same relation to the protoplasm of *Bathybius* as the spicula of sponges or of the *Radiolaria* do to the soft parts of those animals."*

Leaving the question as to the nature and significance of *Bathybius* to be discussed in a future portion of this paper, I have to submit my reasons for asserting—firstly, that the free *Coccoliths* met with have invariably been derived, in the first instance, from the spherical bodies which were discovered by me, in 1860, in soundings from the North Atlantic (and to which I assigned the name of *Coccospheres*, as indicative of their relation to the *Coccoliths* of Professor Huxley); and secondly, that the Coccospheres stand in no direct relation to the supposed protoplasmic substance which has been alluded to.

Both *Coccoliths* and *Coccospheres* were, for the first time, minutely described and figured in a paper by me which appeared in the 'Annals and Magazine of Natural History,' for July, 1861.† They had, however, been previously referred to, in my 'Notes on the Presence of Animal Life at Vast Depths in the Ocean,' published immediately after my return from the North Atlantic, in November, 1860. In the latter paper they are thus alluded to:—"In almost every sample of Globigerina ooze these bodies (*Coccoliths*) have

* *Loc. cit.*, pp. 205 and 210.

† The earliest actual notice of the bodies called *Coccoliths* was that afforded in 1858 by their discoverer, Professor Huxley, in some remarks appended to Captain Dayman's 'Report on Deep-Sea Soundings.' They were there described as "curious rounded bodies, to all appearance consisting of several concentric layers, surrounding a minute clear centre, and looking, at first sight, somewhat like single cells of the plant *Protococcus*. As these bodies, however, are rapidly and completely dissolved by dilute acids they cannot be organic."—('Deep-Sea Soundings in the North Atlantic, made in H.M.S. Cyclops, by Lieutenant-Commander J. Dayman, 1858,' *p. 64.)*

been detected by me. But I have also invariably found associated with them, in greater or less quantity, *certain cell-like masses*, the average diameter of which is about $\frac{1}{1000}$th of an inch, *on the immediate surface of which minute bodies* were regularly arranged at intervals, *so closely resembling the free Coccoliths in look and structure* as to leave little doubt that the latter are given off from the former in some way." I add that "the association of the largest number of both of these kinds of bodies in the soundings in which the *Globigerinæ* were in greatest quantity and *in the purest condition*, is worthy of notice, and is almost suggestive of their being the larval state of these organisms."* Again I state (p. 17) that, "in the nearly pure *Globigerina* deposits, there is no tenacity ("stickiness") whatever, *the minute amorphous particles necessary* for the production of the oozy quality *being almost entirely absent*. They therefore appear to the naked eye as mere aggregations of clean fine sand."

Professor Huxley seems to have been unaware, from what he says in the fourth paragraph of his paper above referred to, that I not only "*suggested*" that the Coccoliths proceed from the *Coccospheres*, but most distinctly stated (in 'The Annals,' July, 1861, par. 2), that I found the Coccoliths occurring "as adjuncts to minute spherical cells, upon the outer surface of which they were adherent in such a manner *as to leave no doubt of that being their normal* position." This paper is accompanied by figures of the bodies under notice, and includes the following description :—"On reference to the annexed woodcut it will be seen that the composite bodies to which I allude, and to which I propose to give the name of *Coccospheres*, are minute spherical cells, having a defined limitary wall, and that upon their outer surface the *Coccoliths* are arranged at nearly regular intervals." Owing, however, to the delicacy of the structure and its minuteness, I had failed, at that period, to ascertain whether the wall of the cell is single or multiple, and also failed to trace the true double-disc formation of the *Coccoliths* which has very recently been pointed out by Professor Huxley, † and which I am now able to confirm in most respects.

Professor Huxley describes, however, what he calls a "*granular zone*" as possibly constituting an integral portion of the *Coccolith* structure, and occupying more or less of the space intervening between the two unequal-sized plates of which it is composed.

Under none of the conditions in which perfect *Coccospheres* have been examined by me (and I have examined them in immense numbers, both in a recent state and in the preserved material of the

* *Loc. cit.*, p. 14. Additional evidence of the relation between these bodies and the *Foraminifera* will be given hereafter.

† In the paper already referred to as published in the 'Quarterly Journal of Microscopical Science,' Oct., 1868.

soundings) have I met with any proof that this zone exists as an integral or even occasionally integral portion of the structure. Indeed Prof. Huxley admits that it is not visible whilst the *Coccoliths* are still adherent, either in what he calls the "loose" or the "compact" type of *Coccosphere*.

On the other hand, where detached *Coccoliths* are to be found mixed up with the more muddy deposits of the sea-bed, or the débris of minute animal and vegetable matter with which they are associated when met with as free floating organisms which have been taken into the digestive cavities of the *Salpæ* and minute Hydrozoa of tropical seas,* granular particles, in each case partaking of the character and colour of the minute matters by which they were surrounded, may often be seen to occupy the space indicated. But there does not appear to me to be any direct proof that the granular zone is anything more than a mere accidental accretion; or that it owes its presence *to any inherent condition without which the organism would be incomplete.* Moreover, as might be anticipated, in those cases where the Coccoliths occur in the material of the soundings, granular particles, apparently identical in composition, may be seen to occupy the minute cavities in dead shells of Foraminifera, in mineral masses, and the like.

The most remarkable circumstance, however (as showing that there is not necessarily any connection between *Bathybius* and the development of the Coccoliths and Coccospheres), is to be found in the fact that in those pure *Globigerine* deposits in which there is scarcely a trace of muddy or slimy substance, the *Coccospheres and Coccoliths* exist also in profusion, and the latter but rarely present the appearance of a granular zone.

I may state that, after a careful and long-continued study of these organisms, whether occurring as free-floating inhabitants of the surface waters of the Indian Ocean and tropical portion of the Atlantic, as constituent particles in the deposits being formed at the bottom of existing seas, or amongst the fossil earths of the Post-tertiary period, I see no reason to alter my opinion by regarding the free *Coccoliths* as having been derived from any other source than their parent *Coccospheres*. In some deep-sea deposits, as stated by Prof. Huxley, free *Coccoliths* do certainly occur in overwhelming number as compared with *Coccospheres*. But, on the other hand, it is equally true that, at times, *Coccospheres* are present in great abundance, whereas free *Coccoliths* are, comparatively speaking, scarce.† Coupling

* I may repeat here, what I announced cursorily in a paper on the *Polycystina*, read by me on the 10th May, 1865, before the Microscopical Society, and published in the 'Transactions' for that year; that I had also discovered Coccoliths in the Barbadoes and other fossil earths; and Coccospheres as free-floating organisms in tropical seas. Towards the close of the same year, I again found them in abundance in the British Channel.

† *In my previously* published observation on the nature of the "oozy" deposits

these facts, therefore, with another very important one, namely, that perfect *Coccospheres* are to be met with of every intermediate size between the $\frac{1}{5000}$th and $\frac{1}{830}$th of an inch in diameter or length,* I am induced to believe that the free *Coccoliths* are formed in every instance on, or *pari passu* with, the spheroidal cells on which they rest; the state of attachment to these cells being the normal as well as pristine condition. That they revert at any future stage of their life history, after once becomming free, to their original composite state, there is no recorded evidence forthcoming to prove.

The question here arises, have these bodies any intimate connection with the origin or development of the Foraminifera of the deep-sea deposits? Now, although the evidence on this head is very far from being conclusive, it is, I venture to say, sufficiently definite to countenance such a view. In some of the deposits in which both Foraminifera and Coccospheres abound, Coccoliths are to be met with arranged in an order so like that in which they occur on the Coccosphere cells, both on individuals of the *Nodosarian Textularian, Rotalian*, and *Globigerine* types, that no reasonable doubt can exist of their having more than a mere accidental relation to the surfaces they rest upon. Thus I have found, side by side, the perfect Coccosphere with its full complement of Coccoliths still adherent, and cells on which the number of persistent Coccoliths gradually dwindled down till only one or two remained, and it became impossible to determine whether I was looking at a Coccosphere cell or a "primordial segment" of a Foraminifer. In both cases (as formerly pointed out by me in 'The Annals'†) the characteristic cross evoked by the polariscope is observable, whilst the density and specific texture of the cell or shell varies apparently with its age; until, in some specimens, we have actually presented to us the complete Foraminifer studded externally, throughout its surface, with the Coccoliths in regular series. The subjoined extract is taken from

of the Atlantic, I have dwelt on the striking difference in character that exists between the immediate surface-layer of the sea-bed, and the stratum beneath; and have pointed out why all *living* animal structures must necessarily be confined to this surface-layer. Although it is now too late to put the matter to the test—and a decisive opinion on the subject can only be formed by an analysis of the deposits the moment they are obtained—it would seem probable that the preponderance of perfect structures, as compared with their exuviæ or débris, is to be accounted for on the supposition that, inasmuch as the former occur on the surface, whilst the latter become the sub-stratum, this preponderance when observable under the microscope, presents itself as a portion of the surface-layer or the sub-stratum happens to be examined. It is quite certain, moreover, that even in the case of the preserved specimens of deep-sea deposits, portions picked out from different levels present different relative quantities of these and other structures also.

* As will be shown on a future occasion, some of the free-floating *Coccospheres* are oblong. It may be mentioned also that although I have here noted $\frac{1}{830}$th of an inch as the largest observed size, very much larger specimens must in all probability exist, inasmuch as I possess mounted specimens of Coccoliths which themselves measure $\frac{1}{900}$th of an inch across their longest diameter.

† 'Annals and Magazine of Natural History,' July, 1861, and January, 1862.

a volume of MS. figures and descriptions which I had the honour of presenting to the Royal Microscopical Society of London last year, and relates to the accompanying sketch of a mature eight-chambered Textularian shell, each segment of which is studded with Coccoliths. The specimen referred to was obtained along with numerous others, from a depth of 1913 fathoms (upwards of two miles) between the coasts of Greenland and Labrador.

"The eight cells constituting the Textularia are quite perfect, and increase in size in the usual manner, from the earliest-formed to the last-formed chamber. The Coccoliths on each chamber are placed in so regular an order as to leave no doubt whatever regarding their being component portions of each calcareous cell. Their structure, moreover, from the clear character of the entire shell, is distinctly visible even under a $\frac{1}{4}$-inch lens. *Textulariæ* thus constituted are by no means so rare as I imagined when I wrote the notice of the discovery in 'The Annals' (already referred to above). In every slide of certain soundings one or more generally occur. The material of this slide has been boiled in *Liq. Potassæ* without any apparent effect on the Coccoliths or Coccospheres. Close by, but detached from the *Textularia* here figured, are several perfect Coccospheres, by means of which a ready comparison and proof of the identity of the cells of the Foraminifer with them can be obtained."

These are the facts, so far as they have as yet fallen under my observation. It remains for future more extended inquiry to determine with certainty their true significance.

Regarding the expediency of attempting to establish a new grade of animal life possessing characters as yet so obscure and indefinite as that on which Professor Huxley has conferred the name of *Bathybius*,* I beg with great deference to express my doubts. In the first place, because I can see no reason to deny to the structure called a Coccosphere, quite as independent an individuality as is observable in *Thalassicolla* or *Collosphæra*. In the second, because the very name *Bathybius*, if its substance is supposed to have any immediate connection with the presence, the development, or the nutrition, of the lower forms of animal life which inhabit the ocean, is in direct antagonism to the occurrence of surface-living forms, for the nutrition and development of which a separate provision would have to be made. And, in the third and last place,

* '*Quarterly Journal of* Microscopical Science,' October, 1868, p. 210 *et postea*.

because it appears to me that analogy, and the bulk of direct evidence, is in favour of the supposition that this widely distributed protoplasmic matter is the *product*, rather than the *source*, of the vital forces which are already in operation at the sea bed.

It is true that the evidence afforded by *Eozöon* may be cited in support of *Bathybius*. But we must not lose sight of the fact that of the animal of *Eozöon* we know as yet extremely little beyond its having been recognized by Professor Carpenter as distinctly of a Rhizopodous type; and certainly not enough to warrant the inference that its body-substance was less highly differentiated than that of an ordinary Foraminifer; or that each individual, within certain limits, may not have been distinct, though inhabiting a structure as vast, in its general proportions, as the coral reef.

But apart from the insufficiency of the evidence on which the existence of *Bathybius* rests, it appears to me that, even were it to be accepted as conclusive, we should not approach a single step nearer to the solution of the problem it may be desired to elucidate—that is, the mode in which the earliest existing form of animal life manifests itself and, in the absence of the conditions without which vegetable life of the most primitive kind cannot be present, obtains nutriment; and becomes, in its turn, food for organisms of a somewhat more complex structure.

Like most theories which admit of being directed towards the solution of the mystery in which the boundary between the animal and vegetable kingdoms has hitherto been shrouded, the idea of a widely pervading protoplasm-layer (drawn on the one side from the assumed analogy of *Eozöon*, and on the other from a substance of the exact relation of which we have also still much to learn, namely, *Œthalium*) would merely thrust before us one difficulty instead of another. For, even if we allow the existence of *Bathybius* as an independent organism, it would still become necessary to invest it with an exceptional specific property—namely, of being able to convert *inorganic* elements into its own body-substance.

If there really occurs in nature a stage (if it may be so termed) at which an exception takes place to the law on which we are accustomed to base the statement that matter already become organic is essential for the sustenance of the life of the animal, it is of little moment, so far as the question itself is concerned, whether such exception occurs in the case of *Bathybius*, of the *Coccosphere*, or of the Foraminifer. But surely it is the least inconsistent with probability to assume that an organism such as a Foraminifer, of whose existence there can be no doubt, and which exhibits sufficient differentiation of its parts at once to stamp it with the attribute of active vitality, should be able to eliminate, from the inorganic elements by which it is surrounded, the particular ones which enter into the composition of its own body-substance. In short, what I seek to

establish is, that in the lowest Order of the animal kingdom, and in the lowest subdivision of that Order, where differentiation has not proceeded beyond a given point and even such indications of specialized structure as a definite "nucleus" and "contractile vesicle" are altogether absent, nutrition is effected by a *vital act* which enables the organism to extract hydrogen, oxygen, carbon, nitrogen, and lime from the surrounding medium, and to convert these ingredients into sarcode and shell-material.

This is, no doubt, in direct opposition to preconceived notions of the distinction existing between the Protophyta and Protozoa, but I cannot help thinking that, on a closer scrutiny of the grounds upon which the distinction is based, it will be found to have its foundation in words rather than in established facts; and that the vital attribute now claimed for the lowest Protozoon is, in reality, as compatible with reason and observed phenomena as some of the other attributes which have been unhesitatingly acceded both to the Protozoa and the Protophyta.

According to Dr. Carpenter, whose well-merited reputation as one of the leading physiologists of our time needs no comment of mine, "There is reason to consider the shell-substance of the Foraminifera as an *excretion* from the protoplasmic mass of which the body itself is composed, just as the cellulose wall of the vegetable cell, which may be consolidated by carbonate of lime (as in Corallines), or by silex (as in Diatoms), is an excretion from the contained endochrome."* But inasmuch as the term "excretion" involves vitality; or, to put the case in other words, since the shell-substance *would not be excreted were the animal dead*, it is obvious that the process is, in point of fact, one of *secretion*, dependent, in the first instance, on the creature's power of eliminating carbonic acid and lime from the waters it inhabits; and, in the second, of reproducing carbonate of lime in the shape of its shell-substance. Unless we admit this explanation, it is difficult to see how we can escape the more serious dilemma of having to assume that solid atoms of carbonate of lime are merely passed mechanically through the animal's body, going in at one side in the shape of solid atoms, and coming out at the other in the shape of specially conformed shell-tissue. And, be it observed, the same objection holds good as regards the *process* by which the "consolidation" of the cellulose wall—by carbonate of lime or silex, as the case may be—takes place in the Protophyte. For it is only so long as we consent to be hoodwinked by a definition which cannot, under any circumstances, be accepted as universally applicable, that any doubts can arise as to there being a gradual, and not a sudden, transition from the confines

* "On the Systematic Arrangement of the Rhizopoda," 'Natural History *Review,' No. 4, October, 1861, p.* 472.

of one kingdom to the other. But, for reasons already assigned, this transition, from the vegetable side, is *not, and probably cannot be*, completed under those conditions which prevail below certain fixed limits of depth in the ocean.

If we admit this much as regards the process of shell deposit, the ground is at once cleared for us; and, *mutatis mutandis*, the elimination from the surrounding waters of the elements entering into the composition of body-substance, and their conversion into this substance by a special vital force inherent in the protoplasmic mass itself, and diffused, in all probability, throughout its substance, becomes at once as easy of comprehension as any vital act can be.*

Lastly, if *Bathybius* be assumed to constitute the nutritive substance of *Globigerina*, it follows that, where the largest and purest deposits of that Foraminifer present themselves, there must be the greatest supply of the nutritive protoplasm. But this is the reverse of what we find to be the case, inasmuch as amongst the purest Globigerine deposits where these organisms amount to 80 or 85 per cent. of the entire mass, hardly a trace of gelatinous matter is observable.

VII.—*On the Mode of Formation of the Blastoderm in some Groups of Crustacea.*† By M. Edouard Van Beneden, Dr. en Sciences à Louvain, and M. Emile Bessels, Dr. en Sciences à Stuttgart.

The splendid researches of Rathke on the development of Crustacea contain but a few vague statements relating to the formation of the blastoderm, and which are not of a character to meet the actual exigencies of science. The various naturalists who subsequent to Rathke worked at the development of the Arthropoda have entered into this important problem of the mode of formation of the first cellular layer of the embryo. The conflicting results at which they have arrived are due in part to real differences which occur in the manifestation of one and the same phenomenon, and in part to differences of interpretation.

For a long time it had been doubted whether total segmentation took place in Crustacea; but the phenomenon has been demon-

* As no useful purpose would be served, so far as the present question is concerned, by inquiring at what point physical forces enter into competition with those which are vital, I have abstained from complicating the subject by reference to them.

† M. Van Beneden, who has very kindly supplied us with the following abstract of his memoir to be published in the 'Recueil des Mémoires' of the Royal Academy of Belgium, has furnished it expressly at our request.

strated positively in *Nicothoë* by P. J. Van Beneden (1848); in Phyllopoda of the genera *Artemia* and *Branchipus*, by Leydig (1851); and finally by Claus in various Copepoda. Then naturalists admitted that the vitelline globes situate at the periphery of the ovum underwent after the segmentation a process of "clearing up," to form the cells of the blastoderm, and that the central globes became fused together to form the mass of nutritive substances surrounded by the blastodermic vesicle.

In other Crustacea the blastoderm is formed without complete segmentation. The Decapoda exhibit, according to Rathke, only a partial segmentation of the vitellus; but the illustrious embryologist did not know of the relation which exists between these segmentation-globes and the blastodermic cells. If we may believe M. Dohrn, the blastoderm in *Asellus* is formed from a blastema in the same way as was pointed out by Zaddach in the *Phryganidæ* and by Weissmann in dipterous insects. M. de la Valette St. George has observed in *Gammarus pulex* that there occurs at the commencement of development a separation into two parts of the elements of the vitellus. The vitellus of formation becomes divided into minute masses, each enclosing a nucleus, and perhaps represent portions of the *germinal vesicle*. These small nucleated masses are so many cells which have only to pass to the circumference in order to form the blastodermic membrane.

We have made a special study of this important histogenetic question, and our researches have been principally made upon these groups of Crustacea, Lerneæ, Amphipoda, and Copepoda.

I. Lerneadæ.

Two very distinct types of development are to be found in this singular group of animals. The first is presented to us in *Chondracanthus;* the second in *Caligus, Anchorella, Clavella, Congericola, Lernea,* and *Eudactylina.*

1st *Type. Chondracanthus.*

In order to give an intelligible account of the first embryonic phenomena, it is necessary to say a few words on the mode of formation and the constitution of the ovum. The ovum in Chondracanthus is at first a minute protoplasmic cell, without a membranous wall, exhibiting very active amæboid movements, and under certain conditions capable of absorbing solid particles and granules of carmine. This cell is at first clear and transparent, and becomes charged gradually with highly refractive nutritive matters, and soon attains its normal volume. In passing along the oviduct the ovum becomes surrounded by a membranous envelope, *which is a product* of the secretion of the wall of the oviduct, and is

consequently a true chorion. This envelope has a micropylar orifice, and thus the ovum in its native state consists of—

1st. A chorion, with its micropyle.
2nd. A vitellus, composed of
(a) a clear and transparent protoplasm;
(b) nutritive elements, suspended in this protoplasm.
3rd. A germinal vesicle, which is the nucleus of the primitive cell.
4th. A nucleolus, the germinal dot or "spot" of Wagner.

The ovum of Chondracanthus undergoes entire segmentation of the yolk. This process goes on in the usual manner, till there are eight distinct segments or globes produced. But at this period each of these globes divides immediately, not only into two, but into four new globes. The number is thus *directly* increased from eight to thirty-two, and from thirty-two to 128. The planes of division all pass through the centre, so that each segment has the form of a pyramid, its base being turned towards the surface of the ovum, and its apex being at the centre.

Before the segmentation terminates there is seen to take place a separation between the two constituent principles of the vitellus: the protoplasm with the nucleus of the segment passes toward the periphery of the ovum; the nutritive elements accumulate in the centre, and then the boundary between the different segments disappears. This process continues until all the nutritive matter is accumulated in the centre of the ovum, and there remain at the periphery only the transparent cells forming the blastoderm. It follows from what we have said:—

(1.) That the formation of the blastoderm results from the division by multiplication of the ovum-cell, and from the separation of the vitelline elements from the protoplasm.

(2.) That each vitelline globe gives rise to a blastodermic cell.

(3.) That the formation of the blastoderm is not, as is often stated, a phenomenon occurring subsequent to segmentation; the latter should be regarded as a first phase in the formation of the blastoderm.

2nd Type. Caligus, Anchorella, Clavella, Lernea Congericola, and Eudactylina.

In all these Lerneans the ovum has exactly the same constitution as that of Chondracanthus; we have not, however, been able to recognize the existence of a micropyle. Total segmentation of the yolk does not occur. The first phenomenon which occurs in the fecundated ovum consists in the complete separation of the protoplasm from the nutritive elements. The protoplasm condenses

round the germinal vesicle, forming with it the first embryonic cell, while the nutritive elements pass towards the periphery. Then the first embryonic cell divides, at first into two and then into four, and these few large cells travel towards the periphery, passing through the larger of nutritive materials. On reaching the surface these cells continue to divide, and thus form a cellular layer which extends more and more, to form finally the blastodermic membrane.

This mode of formation of the blastoderm is essentially identical with that we have described in Chondracanthus. Here also the formation of the first cellular layer of the embryo results from the separation of the nutritive and protoplasmic elements of the yolk, and from the multiplication by division of the ovum-cell. The only difference is that in Chondracanthus this separation takes place after the division of the cell, whilst in Caligus, Anchorella, &c., it is the first phenomenon manifested by the fecund ovum.

II. Amphipods.

What we have said regarding the mode of formation and the constitution of the ovum in Chondracanthus, may also be said of the ovum of Amphipods. The ovum of Amphipods does not present a vitelline membrane; the membrane which Meissner took to be such is a production of the cells of the blastoderm, and consequently an embryonic membrane. The orifice of such a membrane, then, cannot be called a micropyle, as Meissner has termed it.

We have most carefully investigated the process of total segmentation of the yolk in *Gammarus locusta*, and many other marine species. It does not exhibit the peculiar features that we pointed out in *Chondracanthus;* but the diagrammatic figures which we have given in our memoir are identical with those given by Ecker in his 'Icones Physiologicæ,' of the segmentation in the egg of the frog. When segmentation is completed, the ovum is found to be composed of a great number of pyramidal segments, and then there occurs abruptly a separation between the nutritive elements and the protoplasmic matter of the several segments. The protoplasm, enclosing the nuclei of the globes, passes to the periphery of the ovum, to form there the cells of the blastoderm. These become fused together, and form a continuous cellular, which gives rise by secretion to a primary *cuticular* membrane. This it is which was styled the vitelline membrane, and which presents the pretended micropyle.

We have demonstrated, in the case of *Gammarus pulex* and other fresh-water species of Gammarus, the correctness of M. Valette's observations—the blastoderm is formed without any previous segmentation.

III. Free Copepoda.

We have studied the formation of the blastoderm in several marine Copepoda; the ovum which is constituted like that of other Crustacea, undergoes—as Claus has observed—a total segmentation of the vitellus. The form and disposition of the segments at the end of the process are the same as in Chondracanthus and the Amphipoda; and the formation of the blastoderm results from the same series of phenomena. We have here made some very interesting observations, which have convinced us that the *germinal vesicle* does not disappear, but divides to form the nuclei of the segmentation-globes.

Conclusions.

The blastoderm in Crustacea may be formed:—

(1.) *After total segmentation of the vitellus* [*Chondracanthus; Gammarus locusta; Copepoda*]. This phenomenon may present many varying characters, but it invariably occurs in such a way that the globes have ultimately a pyramidal form, and that each furnishes a cell to the blastoderm. The formation of these cells *always* results from the multiplication by division of the ovum-cells, and the separation in each of the globes of the two chief constituents of the vitellus.

(2.) After partial segmentation (Decapoda—Rathke).

(3.) Without segmentation, according to the process pointed out by La Valette St. George in *Gammarus pulex*, and which we have demonstrated in several fresh-water species of Gammarus.

(4.) Without segmentation, according to the very different process which we have found in various Lerneæ.

These different processes are in the main perfectly identical.

The mode of formation of the blastoderm, varying, as it does, within the limits of the same natural groups, and likewise within the limits of the same genus (*Gammarus*), cannot in any way serve as a basis of classification; and we may say the same as to segmentation which takes place in an identical manner in very distinct and unallied groups (Batrachia, *Gammarus locusta*), and varies exceedingly within the limits of the same group (*Chondracanthus, Gammarus locusta*).

NEW BOOKS, WITH SHORT NOTICES.

Bibliothèque des Sciences Naturelles. Anatomie Microscopique, par M. Robin. Paris, 1869.—This, which is intended for a work of reference, deals in the present volume with tissues and secretions. It is very badly printed in very small type, and though containing a good deal of matter under each of the heads it embraces, is on the whole rather unsatisfactory to the working microscopist.

Traité d'Anatomie Descriptif, par M. Ph. C. Sappey. Paris, 1868.—Here we have a new edition of M. Sappey's comprehensive treatise on Human Anatomy. We notice it because it strikes us that, with the exception of Quain and Sharpey's excellent work, it deals more fully and fairly with the subject of Human Histology than any other book we are familiar with. The illustrations are not as numerous as they ought to be, but as cuts intercalated with the text, they are well drawn and carefully printed. The figures of striped muscular tissue are especially good, and show almost at a glance how much of the striation and fibrillation depend on a tendency to cleavage in either the transverse or longitudinal plane. The chapter on connective tissue is a comprehensive one.

The Anatomy of Vertebrates, by Richard Owen, F.R.S. Vol. III. Mammals. Longmans.—We call attention to the third volume of Professor Owen's treatise on the Anatomy of the Vertebrates, because it completes the work, and contains a good deal of microscopic anatomy. The structure, for instance, of the abdominal glands, and the development of the teeth, hairs, blood-globules, and ovum, are given with the usual accompanying illustrations. We note that the author declares his disbelief in the existence of the cell as defined in most physiological text-books, and that he explains the formation of cells by a process very similar to that advocated by Professor Huxley, but which he terms *Formifaction.* The view that Professor Owen takes of the homology of the tooth as a tegumentary structure, is that it belongs to the dermal rather than to the epidermic layer. Some histologists dispute this, but the whole question depends on how we define the epidermis and derma. The author evidently regards everything that is placed below a structureless membrane (basement membrane) as dermic; and as the tooth is certainly covered with a structureless layer (Nasmyth's membrane), he looks on the tooth as dermal. Others, however, dispute the identity of this membrane of the enamel with the so-called basement membrane of the skin. They look on all structures which grow in a direction outwards as epidermic—more correctly *ecderonic*—and all which are developed in an opposite line as dermic (enderonic). The teeth grow from within outwards, and hence they would be in this view epidermal, and not dermal organs, as Professor Owen classifies them. Another point to which

we would call attention is Professor Owen's advocacy of the view that the white-blood globules divide into red ones (so at least we gather from his account). This, our readers will be aware, is a different opinion from that of Mr. Wharton Jones, who regards the nucleus of the white corpuscle as the future red globule. There is a great deal of interesting matter in Professor Owen's volume, and the illustrations are numerous and good.

Observations on the Polyzoa: Sub-order Phylactolæmata; with nine plates, by Alpheus Hyatt, Salem, U. S., 1868. The Essex Institute is one of the most active and useful of the American scientific institutions, and of the many good memoirs it has furnished us with, this is by no means the least either in interest or value. Mr. Hyatt is not only an indefatigable observer himself, but he is also a careful student of the writings of those who have gone before him in this special path of research, and his general "introduction" on the anatomical structure of the group whose history he has written, will be found useful by those interested in Polyzoa. The works of Allman, Van Beneden, Leidy, Busk, Hancock, De Blainville, Dumortier, and Ehrenberg, have been frequently referred to. Professor Allman's work seems to have supplied the author with most of his facts, especially those in relation to general development and the development of the statoblasts. The chapter on the composition of the endocyst seems to us to contain more original matter than any of the others, and embraces a statement of the results of the author opposed to those of Professor Allman. The plates, nine in number, are very pretty, being drawn in white lines in black background, but they appear to us to be generalized from many specimens, and to be in great measure schematic representations. In most instances they are original, and they include species of Fredericella, Plumatella, Pectinatella, Cristatella, and Urnatella. Mr. Hyatt's work is one which those engaged in the study of Polyzoa should read and pass judgment on for themselves.

PROGRESS OF MICROSCOPICAL SCIENCE.

Observations on the Development of the Bony Fishes.—In the last number of Max Schultze's 'Archiv für Mikroscopische Anatomie,' Professor Kupffer, of Kiel, has a paper on this subject, in which he states that he subjected to microscopic examination the ova of several species of fish—the pike, stickle-back, &c., all of them after fecundation. The results of his investigations agree in most points with those published more than ten years ago by Lereboullet. Some phenomena, however, in the development of the fecundated ova have been more accurately observed and described, and the nomenclature has been accordingly slightly altered. Besides the segmentation-cells,

he describes "free cells" in the blastoderm, which are independent of the former. The cell-mass, which spreads out from the "germinal pole," as germinal membrane, completely surrounding the yolk, has been described by Von Baer, Vogt, and others, as forming an incomplete closure, the latter being looked upon as the anus. He has never observed this "primordial anus." He holds, with Lereboullet, that the formation of the embryo begins from the margin of the germinal membrane, the most peripheral part of which he describes as a sharply-defined zone of peculiar cells, not to be confounded with a mere swelling. He applies to it the term "*Saum*," "Keimsaum," germinal fold, part of which he describes as "embryonic shield," which is identical with Vogt's "primitive band" and Lereboullet's "embryonic band." Arising from the germinal shield, he describes the "primitive line or trace," extending into the yolk, and the shield undergoing at the same time a process of depression, presenting the appearance called by Von Baer the "dorsal furrow," but, unlike Von Baer, Vogt, and Lereboullet, he has not been able to observe the formation of a bridge over the dorsal furrow. The formation of two vesicles is then mentioned as the next advance in the process of development, one at the free extremity of the (Kiel) primitive trace, considered to be the urinary bladder or allantois, the other the pericardium. Previous investigators overlooked the early formation of these two vesicles, but Kupffer says, "These structures appear so early, that I may definitely assert that the two vesicles, of which I maintain the anterior to be the commencement of the pericardium, and the posterior the allantois, are the first organs in the embryonic shield which can be observed." Many new facts are referred to, in regard to the development of these ova, such as the appearance of two, and not three, divisions of the brain-section, that the splitting of the germinal membrane into layers proceeds from the middle-line of the shield, the development of the eyes between the two upper layers, and the entire detachment of the horny layer from the upper central line, and the formation of a furrow beneath this layer, raised as epidermis, which (the furrow) penetrates into the chorda dorsalis from above. The author's observations on the way in which the vascular system is formed are incomplete. On this head he says himself "that he has only definitely proved the formation of blood-corpuscles in the wall of the yolk-bag."

The Morphology of the Hair.—In a long and interesting paper by Dr. A. Goette, of Tübingen, the author describes the mode of growth of hair, and its varieties, the number of which he increases by the Schalthaare, "hairs of insertion." The development of the hairs of the embryo, as they are observed about the mouth and the eyes, he describes as follows:—"The first impulse to the formation of a hair is given by a limited cell-proliferation of the cutis, immediately beneath the epidermis. This cell-proliferation raises the latter into a small eminence, which appears to the unaided eye as a white dot. Whilst the closely-packed cells of the cuticular papilla separate towards the connective tissue into a round corpuscle, it is from above surrounded by the mucous stratum of the epidermis, and by continuous growth

pressed downwards." The eminence of the papilla, formed by cell-proliferation, disappears, and instead of it a depression is observed. The fold of epidermis over the papilla extends deeper, and surrounds the latter almost entirely; the hair-sac and the connective tissue around it are developed, and a fibrous and vascular connection is established between it and the papilla. The subsequent increase in the nutrition of the papilla is marked by the formation of a cone above it, which forms the commencement of the hair with its horny shaft, its dark centre, and a bulb below. The spiral course of the sheath of the hair is by the author assumed to determine the subsequent curling of the hair. The falling out of the hair he ascribes to the shrinking of its bulb, its detachment from the papilla, accompanied by a retraction of the external sheath. As regards the formation of secondary or new hairs, he differs from Henringer, who held that the matrix of a new hair is a new outgrowth from the productive soil of the hair-sac, and not from the old germ, and differs entirely from Wertheim's view of new hairs arising independently of the epidermis, and of their growing by chance into old hair follicles. According to Goette, the new or secondary hair grows from the papilla. He describes, however, the mode of growth of a class of hairs which he terms "Schalthaare, hairs of insertion," which do not arise from the papilla, but are produced by an excessive local nutrition in the hair-sac. But this kind of secondary hairs differs essentially from those arising from the papilla. The author terms the former non-papillary, and the latter papillary secondary hairs. The papillary forms have a sheath and a bulb like the primary hairs, but the non-papillary have neither sheath nor bulb, and remain uncoloured even in the most pigmented races until they have reached a certain size, receiving then a streak of pigment from the papilla. They are easily suppressed by the growth of secondary papillary hairs. Goette concludes his paper by some interesting observations on the relations between the fat and hair: "Hairs, like fat, are casual products of the body;" "One structure excludes the other, since it withdraws from it space and material (as in the case of non-papillary hairs);" "Stags, when castrated, yield more fat than hair, and *vice versâ*," &c.—*Ibid.*

On the Reparative Process after Injuries sustained by Muscles.—Formerly it was believed that divided muscles were united by the formation of connective tissue; but Dr. Neumann has observed, "That a bridge of connective tissue is only formed in very extensive lacerations, with much loss of substance." Muscles divided by incisions unite differently. The author made transverse incisions into the Gastrocnemius and Tibialis anticus of dogs and rabbits, and noticed the following appearances in the process of reparation. The sarcolemma retracts and the contractile substance protrudes; an amyloid degeneration of these parts may possibly take place; there is a necrosis of the cut ends, a dark-grained infiltration, and a molecular breaking down of the substance. A vital reaction ensues on the fourth day, marked by an accumulation of muscle-cells. A few days later, some of the fibres form simple continuations, others branch on others—and this the author was the first to observe—lateral

growths or buds are formed. The first fibres have no transverse striæ, are granular, and have many nuclei. Subsequently the nuclei decrease in number, and are arranged in regular alternations. The fibres at first flattened, become now cylindrical, acquire transverse striæ, and their outlines are distinctly visible. The transition from old to new fibres is almost imperceptible. After the division of atrophic muscles, fatty degeneration of the connective tissue followed, the transverse striæ were lost, the fibres became narrower and did not retain their smooth outlines.—*Ibid.*

Colouring with Hæmatoxyline.—The following process for colouring microscopic preparations is described by H. Frey (first introduced by Dr. Böhmer, of Würzburg): Of a solution of hæmatoxyline in absolute alcohol (gr. xx in ℥ss) 2–3 drachms are placed in a watch-glass, which is filled with a solution of alum, in distilled water (gr. ii in ℥i). A violet colour is at once produced, in which preparations are placed for twelve or twenty-four hours. Then may follow a treatment with absolute alcohol, and acid. tart. in alcohol, again with alcohol, then with benzin or oil of turpentine. The preparation may be examined in ol. ricini, in which it acquires a high degree of transparency. Other methods may be used in applying this colour, but acids holding water and the common solutions of resins in chloroform must be avoided, as both are injurious to this colour. Hæmatoxyline-coloured preparations may be kept in glycerine. Preparations which have been treated with other re-agents, such as chromic acid, become blue. The colour adheres especially to the nuclei. The so-called Parme soluble, 1 in 1000 of water, yields a magnificent blue, passing into violet, and colouring the various tissues in a few minutes. After cleaning the preparation in water, it may be examined in glycerine.—*Ibid.*

A new object-stage, that can be heated.—The table described in this paper, by Dr. A. Schlarewsky, is of the size of an ordinary microscope-table, consisting essentially of a brass box, perforated in the middle, and transformed by perpendicular partitions into a system of communicating spaces. Two tables connect this box with a cylindrical reservoir, the fluid in which is heated by a spirit-lamp. One corner of the box is elongated for the reception of a thermometer; from another corner issues a tube for conveying away the water into any convenient vessel. In consequence of the arrangement of the partitions, the moving liquid is forced to run in a given direction through all the parts of the box, and to flow at last round the bulb of the thermometer. Thus the whole box is heated everywhere at a uniform temperature. The actual state of the temperature of the box may be most accurately measured by the thermometer. The central aperture of the box may by various contrivances be adapted to various requirements in respect to moisture and pressure. The advantages of such an apparatus for the examination of such parts as the mesentery in the living body, are obvious.—*Ibid.*

On Measurements of Heat in the Microscope, by Dr. Engelmann, Utrecht.—Investigating into the influence of higher temperatures on *ciliary movements*, Engelmann was obliged to use Schultze's heated

object-table. The temperature of the preparation, however, did not always correspond with that of the table, but was liable to considerable fluctuation through the influence of the objective, for "the temperature of the preparation must depend essentially on the objective, and, as the latter is only a part of the great mass of metal in the microscope, of course on the temperature of the whole microscope." To correct this to some extent, Engelmann inserted an ivory tube, 30 Mm. long, between the objective and the tube of the microscope. The ivory tube being a bad conductor, the graver errors are avoided.—*Ibid.*

Observations on Krause's Membrana fenestrata of the Retina, by V. Hensen.—This short paper has chiefly reference to a dispute between Krause and Hensen about Ritter's filaments on the rods of the retina, the existence of which the former denies, accounting for them by an optical illusion and want of care in using chemical re-agents.—*Ibid.*

On Noctiluca miliaris, by Victor Carus, is a reply to some remarks made by Dr. Doenitz on V. Carus's observations on Noct. mil., anent the parenchyma of its body. Carus has described a gelatinous framework with parenchymatous filaments, ending in meshes beneath the skin, united to the latter by a layer of cells. Dr. Doenitz suspects, that Carus has mistaken sea-water for an organic substance.—*Ibid.*

The Organ of Hearing in Frogs.—Dr. C. Hesse, of Würzburg, has a paper on this subject in Siebold and Kolliker's 'Zeitschrift für wissenschaftliche Zoologie,' Part III. Considerable difficulties must have attended the examination of so ill-defined and minute an organ as the auditory apparatus of the frog, especially as, on account of the cartilaginous encasement of the internal ear, it cannot be lifted out of its connection entirely without being destroyed. Only two entrances into the inner ear were discovered, one for the auditory nerve, and the other the foramen ovale; no foramen rotundum was present. The cartilaginous walls contain fusiform cells. The anatomy of the semicircular canals and the ampullæ in the frog is nearly the same as in man, but instead of the vestibule and cochlea, only a rudimentary vesicular structure is seen, the auditory vesicle. Yet even in this simple structure the rudiments of all those parts may be observed that enter in man and the higher vertebrate animals into the constitution of the vestibule and cochlea. Hesse has carefully traced all of them, and established an analogy between these rudimentary parts and the corresponding structures in the ear of man. The first division of the auditory vesicle of the frog is effected by a perpendicular partition into the pars vestibularis and pars cochlearis, the former communicating with the semicircular canals and the ampullæ. The p. vestibularis or utriculus communicates also with the p. cochlearis by means of the apertura utriculi, a spot where the partitional division between these two cavities is incomplete. The walls of these compartments are lined partly with pavement epithelium, and partly with cylindrical dentate cells and rod-cells. It is the latter, that are of special importance, as constituents of the organ of hearing. They are confined to special parts, such as the macula and the papilla acustica. The

rod-cells have a distended middle portion, and contain a nucleus. The neck of such cells is elongated, and the free margin is furnished with a projecting hair or filament. Between the rod-cells are the dentate cells. Hesse has succeeded in tracing the termination of isolated nerve fibres, and describes them as ending in the rod-cells. On the epithelium of the papilla acustica rests a membrane, "membrana tectoria," first described by Deiter, which receives in its substance the hairs of the filaments of the rod-cells. Corti's cells were everywhere absent, but Hesse does not locate the perception of sound exclusively in Corti's fibres, but assigns it also to the vibrations of the membrana tectoria, and the secondary vibrations of the filaments of the rod-cells. Comparing the ear of the frog with that of the higher animals, the author says:—"Ampullæ and semicircular canals are here as much differentiated as in the higher animals, but all the remaining parts, with the exception of the lagena, do not rise above the level of the auditory vesicle." "Yet all parts are present; those most essential have remained the same, only those which are inessential are variously modified, as is likewise the method of their arrangement." The author is anxious to extend his investigations to fishes and the higher animals, to make the chain of observations complete, "and in order, if possible, to find the general principle in the structure of the auditory apparatus here verified, namely, the attachment of an isolated nerve fibre to an isolated cell provided with a vibrating hair, which terminates either in a vibrating membrane, or rises free into the endolymph."

The Anatomy of the Genus Gordius.—Dr. H. Grenacher, Würzburg, has made investigations on this animal by means of transverse sections with a razor. Tropical animals were chosen for examination. The external layer of the cuticle contains papillæ, some of them provided with threadlike processes of considerable length. The papillæ are coloured; canals exist in the epidermis. The ventriculus extends as a cylindrical canal from before backwards. The author considers it the homologue of the abdominal line of the nematodes; it divides behind; its functions are unknown. Beneath the epidermis is a muscular stratum; its fibres do not anastomose. The intestine is surrounded by the perienteric cellular tissue, consisting of beautifully arranged pentagonal or hexagonal cells, resembling vegetable cellular tissue. The intestinal canal and the several organs are inseparably united. The sexual organs are fully developed, even in the parasitical state of the animal. The intestinal canal has no independent termination, but enters into the uterus. The uterus divides towards the front into two lateral oviducts and a central receptaculum seminis. Higher up appear the ovaries. Subsequently the intestine changes its place, lying not superiorly but inferiorly to the receptaculum seminis. Advancing still higher up, the receptaculum seminis disappears, and the ovaries occupy nearly the whole of the internal parts, and the intestine becomes triangular. In the male the cloaca lies in the immediate neighbourhood of the place where the body bifurcates, and receives the vasa differentia and the intestine. *A mouth* has been discovered, but its connection with the intestine

could not be made out. It has always a mouth as a parasite, but when leading an extraneous existence the mouth most likely atrophies, for no trace of such an opening can then be discovered. The author concludes: "The mode of life of Gordius does not militate against this assumption, for it must appear questionable, whether and how a worm, dwelling for nine-tenths of its life in the intestine of insects, leaving them only to discharge its sexual products before it dies, whether and how such a creature is still capable of seeking and assimilating food in the aquatic element?"—*Ibid.*

The Chitonæ, by Dr. Reincke, of Altona; *The Shelless Radiolariæ of Fresh Waters*, by G. W. Focke, Bremen; *On Fossile Euniceæ, from Solenhofen* (*Eunicitis avitus*), *besides Observations on Fossil Worms in general*, by Dr. Ehlers, of Göttingen, appear in this Zeitschrift.

On the Conditions of the Lymphatics in Inflammations, by Dr. F. Lösch, of St. Petersburg.—Inflammation was induced artificially in the peritoneum and testicles. The white blood-corpuscles were observed to move more or less rapidly. Subsequently a stasis took place, and the lymph of the lymphatic vessels diminished or disappeared. The author concludes that in the course of inflammation the formation of lymph ceases altogether. Blood was observed in lymphatics not only after traumatic injuries, but also after venous congestion. But how does the blood get into the lymphatics? It cannot be explained otherwise than by assuming that the red blood-corpuscles, with the diffused parenchymatous fluid, pass into the lymphatics through apertures which probably exist in the epithelium, although such a process has not yet been observed.

On the Organization of Thrombus.—That coagulated blood within vessels is capable of being converted into organized connective tissue was known to T. Hunter, Stilling, &c., yet "*whence* the connective tissue takes its origin, *how* the vessels of the thrombus arise, *where* and in *which way* the fibrine and the red blood-corpuscles disappear, are questions far from being decided." Reinhard advocates the peripheral development; Virchow, the organization from within. Dr. N. Bubnoff, of St. Petersburg, has made the following observations after injections of cinnabar into the jugular vein, and the formation of a clot. Contractile cells are formed in the different strata of the wall of the vein containing cinnabar. The red blood-corpuscles disappear in the clot on the 6th day; the cells with cinnabar increase, become fusiform or divide (12th or 14th day), and the thrombus is completely organized. The author concludes, "The contractile cells, which are formed outside the wall of the vein, travel gradually through it, and arrive at last in the interior of the vein, even as far as the centre of the thrombus."—*Archiv für Pathologische Anatomie and Physiology and für Klinische Medizin.* Edited by Rud. Virchow.

The Anatomy and Development of the Fresh-water Polyzoa (Phylactolœmata).—On this subject the last number of Reichert's and Du Bois Reymond's Archiv contains a very valuable paper by Herr H. Nitoche. It is illustrated by four plates, containing

numerous carefully drawn sketches of the general structure of these molluscoids and describing the development of the statoblast.—*See Heft IV.*

The Spontaneous Formation of White Blood-Globules (Leucocytes).—M. Onimus gives us an excellent summary of his investigations on this point in the 'Journal de l'Anatomie.' He believes he has proved that a perfectly amorphous liquid, like that formed under the ampulla of the epidermis, raised by a blister, is capable of developing corpuscles identical with those of the chyle and blood. In his first experiments the liquid from a blister, previously filtered, was injected under the skin of a warm-blooded animal. In a short time the liquid was found full of leucocytes. In the present paper M. Ominus gives full details of more elaborate experiments, and combats the arguments urged against him. He states that many of the inquiries have been conducted under the eyes of MM. Legros and Robin, who have verified them; and he quotes some observations of M. Bernard which endorse his views. In his latest experiments he separated the liquid to be experimented on from the blood by means of parchment or membrane, and he thinks that the white globules could not have made their way through this. There is, however, reason to believe from other observations that this passage is at least within the range of possibility.—*See Nos. for November and December.*

A New Species of Sarcoptidæ, of the Genus Glyciphagus, is recorded in the above-mentioned journal, by M. Robin. This he has called *G. Hericius*, and he states that its character leads to a revision of the diagnostic features of the genus. It lives on the liquid which bathes the peculiar ulcerous growth of trees, such for instance as the elm (*Ulmus campestris*). The locomotion is slower than that of other species, and when walking it bends the rostrum downwards nearly at a right angle with the axis of the body. The movements of the males are more active than those of females, or nymphs. They multiply with great rapidity. The ova are deposited before segmentation has commenced. M. Robin describes minutely the anatomy of the skeleton, the integument, its appendages, the anus, and the reproductive system. Several plates accompany the paper, and display illustrations of the perfect animal and of the structure of the different systems.—*Ibid.*

The Spiral Lamina of the Cochlea of Man and Mammalia.—This is a long and very valuable memoir in the above journal, from the pen of M. B. Lœwenberg. It extends over nearly thirty pages, and is illustrated by two handsome plates.

The Brain in Edentala is an excellent anatomical memoir in the same journal. It is by M. Ponchet, and is to be continued.

The Functions of the Roots of Plants. The Annales des Sciences Naturelles (Botanical Section), t. IX., contains the continuation of M. Corenwinder's memoir on this subject. M. Corenwinder in the main concludes that the functions of the root have been very fairly expressed by Baron Liebig in his 'Natural Laws of Husbandry.' He

thinks it may be generally said that the carbonic acid is absorbed by the leaf and the mineral matter (in solution) by the roots.

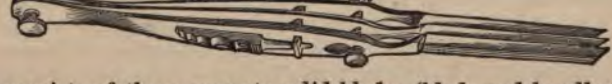
The Fossil Arctic Flora.—Under this head the same number of the 'Annales' contains a review by the Count Gaston de Saporta of M. Oswald Heer's well-known work 'Flora Fossilis Arctica.'

The Formation of the Spores in Mugeotia genuflexa.—M. Ripart has published a good paper on the Formation of the Spores in this Alga, and has illustrated his views by a number of well-executed sketches. The author states that his latest observations perfectly confirm his earlier ones, and utterly go against the views propounded in the third fasciculus of M. Rabenhorst's 'Flora Europœa Algarum aquæ dulcis et submarinæ.' His observations are of some importance, as many algelogists believe that the spores of all the genus are unknown. Dr. Ripart describes and figures them both in their earlier and more developed stages, and he has shown the filament in copulation.—*Annales des Sciences Botaniques*, t. IX.

NOTES AND MEMORANDA.

The Solution of Canada Balsam.—Mr. Jos. J. Forster, of Newcastle-on-Tyne, sends us the following note:—Many people experience considerable trouble in getting balsam to harden on the slides they may have mounted. For some twelve months past I have avoided this difficulty by preparing it in the following way:—I got some very old balsam, and in a "cool oven" allowed it to thicken to a stiff paste, then mixed freely with benzole. The great advantage arises from the balsam setting as soon as the slide is cool, and in twenty-four hours being quite hard.

Triple-bladed Section-Knife.—Dr. Maddox sends us the following:—In the early part of the present year, when making sections of various soft tissues, I felt the want of some method by which a double section might be cut so as to present, when removed, the opposite but contiguous surfaces of the part through which the section had passed, and which with the ordinary double-bladed knife is often quite impossible. This led me to forward drawings to Mr. Baker, instrument maker, of 244, High Holborn, for guidance, and to whose skill in carrying out my design I feel indebted. This section-knife now stands, I believe, as the first triple-section-knife offered to microscopists. Its construction will be easily understood from the figure.



It consists of three separate solid blades (blade and handle in one piece), the middle one with nearly parallel surfaces, thinner than the

outer ones, which at their cutting parts have the middle surfaces slightly concave, and the external surfaces obliquely or double-wedge shaped. The three blades have two cutting edges, one a trifle more curved than the other, the points or tops being cut in a slanting direction. Near the centre, the middle blade has a couple of opposite fixed eyes, which pass through transverse slots in the outer blades, these having each a spring-thumb-slide catch, which can be pushed through the projecting eye. The blades are held together by a screw and nut at the end of the handle, and when released at the thumb-catches, tend to spring outwards, but when the catches are pushed through the eyes, the blades are brought into opposition. To open the blades the necessary width, a tangent screw, passing through each outer blade, acts against the middle one, parallelism being obtained by regulating the distance the thumb-slides are pushed through the eye-loops, and screwing or unscrewing the two tangent screws. Sometimes it may be necessary to very slightly release the screw nut at the end of the handle. The advantages I claim for this triple-section-knife are these:—

Two parallel sections of *similar* or *dissimilar* thickness can be cut from one part, which when spread out will offer a double surface for examination and facilitate tracing the parts of contiguous surfaces. This in pathological researches may be of moment, as assisting the microscopist to find the adjoining points of healthy and diseased structures. By the removal of an outer blade it is converted into an ordinary double-bladed section-knife. Facility for cleaning the surfaces after use, and the little chance of any of the parts being misplaced.

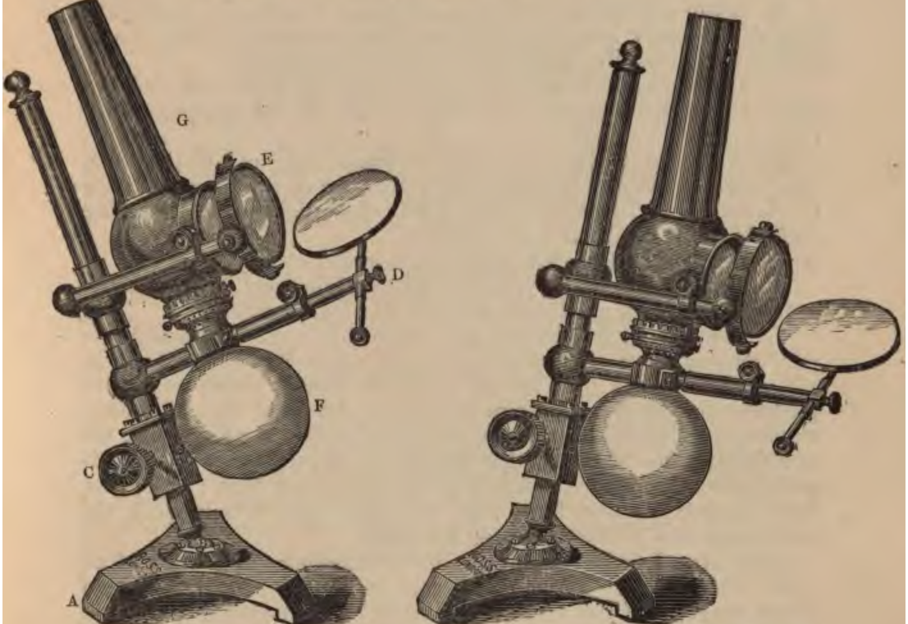
My first sections with one of these knives were most successful, being entirely through the tongue of a newly-born puppy in the direction of its length. The blades require to be well wetted with the liquid most suited for the specimen, or one which will not injure either the knife or the structures. The object may be placed on fine cork, parchment, or thick leather, being held steadily between the finger and thumb, the sections being made by one saw stroke if possible; or the object may be simply retained between the finger and thumb in making the section. It may be said this knife differs but little from the ordinary section-knife; such is the case, yet it is this little that makes all the difference.

A New Lamp for Microscopic Purposes has been devised by Thomas Fiddian, Member of the Birmingham Microscopical Society, who sends us the following account:—

The importance of artificial light for the illumination of microscopic objects has long been admitted by men of science. To professional men and amateurs, whose time is fully occupied with other pursuits during the day, it is an absolute necessity, and even to those who have ample leisure hours of daylight its importance is very great, for it cannot be denied that in our climate the quality of natural light is very variable. The difficulty has been to obtain a concentration of intense white light upon the object, and at the same time to exclude *all extraneous* light from the object and from the eye of the observer.

Sir David Brewster, in a paper on the 'Principles of Illumination of Microscopic Objects,' published as far back as 1831, says:—

"*The eye should be protected from all extraneous light, and should not receive any of the light which proceeds from the illuminating centre, ex-*



cepting that portion of which is transmitted through or reflected from the object. The light which is employed for the purpose of illuminating the object should have as small a diameter as possible." And again in the same paper:—"*In the illumination of microscopic objects, whatever light is collected and brought to the eye beyond that which is fully commanded by the object-glasses, tend rather to impede than to assist distinct vision.*"

These are the principles laid down by Sir David Brewster, and they are by no means obsolete, although his ideas of carrying them out certainly seem rather crude at this time of day, when science has made such rapid strides. For instance, he says:—"*For illumination at night a common bull's-eye lantern may be used with great advantage.*"

It has seemed very strange to me that Sir David's principles should have been acknowledged so long without any adequate attempt being made to arrive at perfection in carrying them out practically, and I turned my attention to the subject. I am not vain enough to imagine that the lamp I have invented will never be improved upon or superseded by something more perfect; but from opinions I have had from those whose experience renders them competent judges, I think I may fairly claim for my lamp the merit of being the most effective microscope lamp yet invented. As will be seen from the

subjoined description of my lamp, I have endeavoured to make it a practical realization of Sir David's ideas on artificial illumination.

A. A small brass tripod foot sufficiently heavy to keep the lamp steady and in any position, and so formed as to take up very little room on the table and not to be in the way of the stand of the microscope.

B. A cup-and-ball joint moving stiffly and keeping the lamp quite firm at any angle, and so constructed that it cannot be inclined at a greater angle than the lamp will burn steady and clear.

C. Rack-and-pinion motion extending to 12 inches, so that the light can be directed upon the stage of the largest microscope for opaque objects.

D. A short arm projecting from the lamp carrying a sliding-tube, which carries either a Rainey's Light Modifier or a concave reflector of plaster of Paris, giving a pure white cloud light when examining such objects as bone and wood sections.

E. Condensing lens, with sliding-arm and clamping-screw.

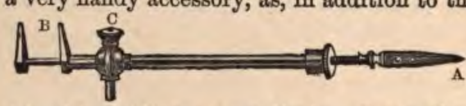
F. White opal glass reservoir in revolving collar, holding a sufficient supply of paraffin for seven hours' consumption.

G. Metallic shade chimney with white lining, fitted with movable cell, holding a disc of thin glass, forming a perfect shade to the eyes, and condensing the light in one direction, thereby doing away with the great objection to *all lamps* hitherto constructed, that of broken chimneys. The drawings show the lamp in two positions, one for illuminating the mirror of the microscope, and the other for illuminating the achromatic condenser when using high power objectives, thus obtaining direct light from the lamp and still keeping the microscope at a convenient angle for vision.

This lamp I find most effective in illuminating any portion of an aquarium, as it will concentrate a cone of light through any portion of the tank. For the micro-spectroscope it is most invaluable, and with the present range of rack-motion it will be found of advantage to the surgeon in using the opthalmoscope or larynxscope.

I cannot conclude this notice without tendering to Mr. Thomas Ross my best thanks for the assistance he has given me, and also the perfect manner in which he has carried out my ideas in the manufacture of the lamp.

Ross' New Microscopic Vice, with stage forceps, of which we annex a diagram, is a very handy accessory, as, in addition to the usual light



spring points A, for holding any delicate minute fibre or piece of tissue, it has, at its other end, a pair of small jaws B, which by means of a milled edge C at the end of the tube sliding through the ball and socket-joint D, can be separated with the greatest precision to any extent up to an inch, and will be found very useful for holding various solid objects whose faces are irregular or not parallel with one another, by enabling the observer to bring any face of the object under view with the greatest facility.

PROCEEDINGS OF SOCIETIES.

ROYAL MICROSCOPICAL SOCIETY.

DONATIONS to the Library and Cabinet of the Royal Microscopical Society, from June to December, 1868:—

	From
Forensic Medicine	*Dr. Guy.*
Popular Science Review. Two Parts ..	*Editor.*
Student. Six Parts	*Publisher.*
Journal of Linnean Society. Five Parts ..	*Society.*
Transactions of ditto. Vol. 26, Part I. ..	*Ditto.*
Journal of Quekett Club .. .. Transactions of the Northumberland and Durham Natural History Society	*Club and Society.*
Epidemic Cholera and Yellow Fever in the U. S. Army, 1867	*Surgeon-General, U.S.*
Acta Universitatis Lundensis Sweden for 1866–7	*University.*
Set of Photographs of Nobert's Test Plates	*Surgeon-General, U.S.*
Journal of Geological Society. Three Parts	*Society.*
The Development of Striped Muscular Fibre in Vertebrata, by Dr. Braidwood ..	*Author.*
Smithsonian Reports for 1866	*Institution.*
Geological Researches in China and Japan, by R. Pumpelly, Esq.	*Smithsonian Institution.*
Three Volumes of U. S. Patent Office Reports for 1865	*U. S. Government.*
Die Wunder Unfichtbaren Welt, by Dr. Jäger	*F. C. S. Roper, Esq.*
Land and Water, Weekly	*Editor.*
Journal of Society of Arts, ditto	*Society.*
Scientific Opinion, ditto	*Publisher.*
Two dozen Slides for Cabinet	*F. R. Martin, Esq.*
One dozen ditto, ditto	*Dr. Braidwood.*
Two-and-a-half dozen ditto, ditto	*Mr. Norman.*
One dozen ditto, ditto	*Dr. A. R. Betts.*

WALTER W. REEVES,
Curator, &c.

9th December, 1868.

On this evening no paper was read, the Council having invited Dr. Carpenter to exhibit specimens of microscopic objects obtained in his recent Deep-sea Sounding Expedition, and to make explanatory remarks thereon.

Dr. Carpenter began by stating that he was not at that time in a position to lay before this Society a paper for publication, as the Royal Society was entitled to priority.

The deep-sea dredging of M. Sars, jun., had led to very interesting results, and Professor Wyville Thomson had suggested an English expedition for the purpose of exploring the sea bed between the north of Scotland and the Faroe Isles. He (Dr. Carpenter) brought the matter before the Council of the Royal Society, which entered warmly into the plan.

General Sabine had indeed been with Sir J. Ross when a star-fish and worms were brought up from a depth supposed to be 1000 fathoms, and probably not less than 700 or 800.

A letter was written by General Sabine to the Admiralty, making application for a suitable vessel, and the request had the advantage of being supported by Captain Richards, Hydrographer to the Admiralty. The Admiralty having consented, the 'Lightning' was equipped for the purpose, with all needful appliances, under the command of Captain May. It was specially proposed to work in a line known to be of from 500 to 600 fathoms' depth, between Scotland and Faroe Isles. One important point in this expedition was to ascertain the sea temperature at various depths with greater accuracy than had been attempted before. Three thermometers were always sent down for this purpose, and no indications accepted unless two of them agreed.

The average temperature of the surface (in August) was from 52° to 54½° Fah., but in lat. 60° 10′, long. W. 5° 69′, they found the temperature at the sea bottom only 32° at a depth of 550 fathoms, a result somewhat unexpected, as physical geographers had stated that the lowest sea temperature was 39°; but they had not taken into consideration the actual temperature at which the greatest density of salt water occurred, nor had they noticed the effect of pressure in retarding freezing. This Arctic current appeared to divide the warm Gulf Stream current into two forks. Upon a bank in the cold area, 170 fathoms below the surface, the temperature was 41° 7′, while at another point on the north of Scotland, at same depth, the temperature was 48° to 49°, and *Terebratula cranium*, Norwegian Foraminifera, were more abundant. At another spot, 500 fathoms deep, several types of animal life were found. In the warm area at the same depth they met with an immense variety of animal life, including *globigerina* mud, Huxley's coccoliths, and Dr. Wallich's coccospheres. Out of this mud four masses tumbled, which proved to be silicious sponges, disclosing, when washed, a structure as beautiful as Euplectalla. They were formed of interlaced spicules one layer over another, and belonged to a new type. A number of smaller silicious sponges, mostly new, were dredged up, together with new rhizopods and extraordinary specimens of known types. Among these objects were specimens of Hyalonema, with the long fibres protruding into the mud, like roots. There were also mollusks, echinoderms, and crustaceans, showing the "richness of marine life at 500 fathoms' depth; and one especial object of search, the Rhizocrinus of Sars, was among the captures." The mud was so viscid that it was difficult to extract jointed objects from it without breaking them.

Dr. Carpenter then referred to the protoplasmic network in deep sea mud, which Professor Huxley had termed Bathybius, and which,

as Dr. Wallich had stated, was limited to the warm area, and not found where the Arctic currents prevailed. This protaplasmic mud extended widely north-west of Shetland, and was dredged up 200 miles from Ireland, at 650 fathoms' depth. In the sounding apparatus, the sand brought up was almost entirely composed of globigerinæ.

It seemed as if, when the temperature was warm, animal life might be carried by gradual subsidence of the sea bed to almost any depth—a conclusion which, however, was not novel, as it had been previously advanced by Dr. Wallich. Thus Edward Forbes's theory, that life was a function of depth, and stopped altogether at 300 fathoms, was completely overthrown.

Many forms of Foraminifera, which were supposed only to attain a large size in tropical seas, were discovered in this expedition, from which it appeared that they were not dwarfed by great depths, as had been supposed, but could grow to large size under such conditions if the temperature was not too cold. Many sandy Foraminiferæ were met with quite unprecedented in size, and among them large single-chambered species, with stellar prolongations, some triradiate, some tetraradiate, occasionally with the branches in a rudimentary state, and all exhibiting a symmetry quite remarkable when we consider the low type of animals by which they were formed.

Some cells composed of sand grains, when broken, exhibited objects like ova or yellow spherules, resulting from the division of a sarcodic mass into zoospores.

The following gentlemen have been duly elected Fellows of the Royal Microscopical Society :—

June 10*th*, 1868.—Edward Davy Harrop, Esq.; Josh. Russell, Esq.; Robt. Luke Howard, Esq.

October 14*th*.—James Parkinson, L.D.S.; Henry Lawson, M.D.

November 11*th*.—James Roy Eddy, Esq.; E. W. Wild, Esq.

December 9*th*.—Francis Codd, Esq.; Henry King, Esq.

Walter W. Reeves,
Assistant Secretary.

King's College, *Dec.* 10, 1868.

High Wycombe Natural History Society.

The first Conversazione of this Society was held on the 24th of November, at the house of the President, the Rev. T. H. Browne, F.G.S., and was largely attended. The President delivered an interesting address, which, however, more immediately concerned general natural history than microscopy. The Secretary read an important paper on "Plant Names," and the evening concluded with an exhibition of microscopic objects, among which were the saw of the saw-fly, the oil-glands of the leaf of *origanum onites*, and the tongue of mollusks.

Bristol Microscopical Society.

The last report received from this Society is of the meeting of Nov. 19th, Mr. W. J. Fedden, Vice-President, in the chair. A paper was read by Dr. C. T. Hudson "On the Anatomy of *Triarthra longiseta*," which was illustrated by numerous microscopic specimens and diagrams.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, December 1st, 1968.—R. Angus Smith, Ph.D., F.R.S., Vice-President, in the Chair.—'Note on Professor Williamson's paper "On an undescribed Type of Calamodendron from the Upper Coal Measures of Lancashire,"' by E. W. Binney, F.R.S., F.G.S.

I had not the pleasure of hearing Professor Williamson's paper on *Calamopitus* read, but from the abstract printed in the 'Society's Proceedings' it is quite evident that the Professor's plant is very different from the *Calamodendron commune* described by me in the last volume of the 'Transactions of the Palæontographical Society.' I have found casts of the pith of the *Sigillaria vascularis* which ordinary collectors would call a *Calamites*, and in two specimens of *Dadoxylon* I have met with *Calamites cannæformis* as the pith of one, and *C. approximatus* as the pith of the other. *Sternbergia* has long been known to be the pith of *Dadoxylon*, so now the genus *Calamites* in all probability will have to be very considerably modified and some of its species classed with other genera. Some years since that profound botanist the late Dr. Robert Brown, in a memoir printed in the 'Transactions of the Linnæan Society,' vol. xx., p. 3, 1851, gives some account of *Triplosporites*, an undescribed fruit which had lately come into his possession. This fossil was the upper portion of a cone which showed sporangia full of minute spores in a beautiful state of preservation. The author, after the examination of a similar specimen in M. A. Brongniart's cabinet, was inclined to refer the plant to the genus *Lepidostrobus*. Mr. Carruthers, of the British Museum, after examining Dr. Brown's specimen, in a paper printed in the 'Geological Magazine' for October, 1865, on an undescribed cone from the coal measures near Airdrie, Lanarkshire, came to the conclusion that it was a *Lepidostrobus*, and named it *L. Brownii*. Another specimen exactly resembling Dr. Brown's is in the museum at Strasbourg. In the 'Comptes Rendus' of 7th August last, Professor Adolph Brongniart describes a wonderfully perfect cone identical with Dr. Brown's specimen in the upper portion of the cone, with sporangia full of microspores, but in its lower part having sporangia full of macrospores. This cone, then, as in Lycopodiaceæ of the genera *Selaginella* and *Isoetes*, has two kinds of sporangia, those near the summit containing the microspores, that is to say, the fertilizing spores, and others near the base of the cone containing the macrospores or germinating spores. M. Brongniart is inclined to class the fossil plant as distinct from *Lepidostrobus*, under the name of *Triplosporites Brownii*. He says that it presents a singular combination of characters, having spo[illegible] ·logous to those of *Isoetes*,

united to a cone or spike resembling that of the Lycopods. He states that nothing was known of the age of the deposits from which the three specimens above named came except the last, and of course this gave little evidence of the true age of the fossil, which was found in drift. Now this information I am able to supply, having obtained some years since a beautiful specimen in all respects exactly similar to Dr. Brown's, from the Roof mine lying immediately over the Gannister seam in the lower part of the Lancashire coal-field; so there is no doubt whatever that the fossil cone is of carboniferous age. Mr. C. Baily, in a letter addressed to Mr. Brockbank, states that the chief portion of the vegetation referred to in his, Mr. Brockbank's, paper "On the Hæmatite Iron Ores of Whitehaven," consists of dark-coloured fragments of the stems of a dicotyledonous plant which seem to have been broken sharply off while growing *in situ*. They have the general appearance of rotten sticks, and in their fresh condition are very soft and friable, yielding readily to the knife, but with exposure to the air they dry, and become much harder. They appear to have belonged to a shrubby plant of no great size, the stems of which would range between half and three-quarters of an inch in diameter. The internal portion of the stems has almost entirely disappeared, and in the few fragments examined, there are no traces of any woody layers, medullary rays, or central pith. The portions preserved consist of true bark, which is made up of two layers:—an exterior layer, or periderm, which is in a good state of preservation; and an interior fibrous portion or liber, made up of short rectangular cells, which form layers of considerable thickness. All the woody fragments examined belonged to aerial portions of the plant, but there are no remains of the leaves borne by these stems, and it would be very desirable that they should be sought for in the lower portion of the overlying clay, as they would be very helpful towards determining the species. If a conjecture might be hazarded from the nature of the fragments examined as to the particular plant of which they formed a part, I should refer them to some species of Betula (birch). There was a single piece of woody matter looking like the rhizome of a fern, but the presence of scalariform tissue failed to be detected in it, and the fragment was too small to draw a definite conclusion from. Intermixed with the stems referred to above are the leaves of some cryptogamous plant, like those of a Hypnum, and formed of square-shaped transparent cells; and embedded in the earthy portions which make up the remainder of the mass are a few well-preserved threadlike roots, which are white in colour, cylindrical in shape, only slightly branched, and containing well-defined vessels.

At the meeting of this Society (Nov. 3rd), Professor W. C. Williamson made some important remarks on the structure of the calamite from the upper coal-measures, represented in Fig. 478 of Lyell's Manual (5th edition). He pointed out the existence of one calamite within another, the former representing the pith and the latter the exterior of the bark, the pith and bark being separated by a well-defined woody zone. This woody zone consists of a series of tissues radiating, as in the recent coniferæ, from the pith to the bark;

but instead of being all alike, they consist of two structures which are arranged in alternating wedges. One of these is entirely composed of elongated cells, but which, being arranged in linear rows radiating from pith to bark, and being separated from the former by a defined line, this tissue is to be regarded as a modified form of pleurenchyma rather than of parenchyma. The intermediate radiating laminæ or wedges resemble slices cut out of a coniferous dadoxylon, having the same reticulated fibres and muriform medullary rays, the latter consisting of a single vertical row of cells. These structures replace corresponding wedges in the calamites recently described by E. W. Binney, Esq., but in which latter the wedges consist wholly of masses of scalariform tissue unfurnished with medullary rays. Immediately below each node Professor Williamson pointed out the existence of a verticil of prolongations of the pith, penetrating the *cellular* wedges of the woody layer like the spokes of a wheel. These he terms "verticillate medullary radii," to distinguish them from the ordinary medullary rays of the *fibrous* wedges. These fibrous and cellular wedges run uninterruptedly in a longitudinal direction along each joint or internode of the calamite, but at each node their arrangement is altered. If prolonged, the cellular wedges of one joint would run into the fibrous wedges of those above and below it. But as the fibres of the fibrous wedges are continued from one internode to the other, they break up as they approach each node, their fibrous laminæ being twisted in an extraordinary manner as they cross the node, in order to redistribute themselves right and left to the fibrous wedges of the joint above. In this part of the plant the fibrous laminæ and medullary rays and the cells of the cellular layer become intermingled in a remarkable way. At the base of each cellular lamina especially the fibres radiate from a common centre in an almost inexplicable manner.

Brighton and Sussex Natural History Society.

The last report of this Society, though full of interesting matter, contains no abstract of papers on microscopical or histological subjects.

Oxford Microscopical Society.

We are sorry to learn from the Secretary (Mr. H. M. Tuckwell) that the meetings of this Society have for some time past been suspended. We observe therefore with some surprise the statement of one of our contemporaries, that it has made arrangement for reporting the meetings of this Association.

Reading Microscopical Society.

17th Nov. 1868.

At this, the annual meeting of the Society, the retiring council and officers presented their report and financial account, after which the President and Secretary were re-elected and a new council chosen.

The paper for the evening was by the President, Captain Lang, and was entitled "Some further Remarks on the Proboscis of the Fly and the Spinnerets of Epeira diadema."

It was in continuation of a paper read before the Society in December, 1867, and began by remarking upon the unsatisfactory character of the mounted slide of the proboscis, as usually sold, which from its flattened arrangement gives a very inaccurate idea of the real organ. The writer suggested that in order to gain a better idea of the object, the fly itself should be soaked in Liquor Potassæ for a week or so, and then viewed, under the dissecting microscope, when lying on its side in a drop of clear water. This will show the various parts in profile, and in their relative position. Then cutting off the entire head, let it be placed on a slide, in a drop of water, with the compound eyes upwards, so that the front, and not the top of the head may be seen. Being then pressed by a dry slide, the proboscis will be exserted, the lobes everted, and the natural position of the palpi will be seen to be very different from that which the mounted slide seems to present; for while that shows the two chitinous "straps," or fulcra, as apparently binding down the palpi, the palpi are really above them.

After referring to the probable nature of these fulcra, the writer described the teeth, which may be seen at the bases of the ten furrowed channels, and arranged three-deep, making thirty on each side. These seem to be unnoticed in descriptions of the proboscis. They are long, formidable, two-pronged organs, free anteriorly, and may be made out in the mounted slide; but there they appear to be in the same plane with the lips; whereas in nature they are not so. The arrangement and number of these teeth seem to vary in different flies, for while the blowfly has three rows, in Musca domestica there appears to be but one.

The spinnerets of Epeira diadema were described as consisting of three pairs of somewhat conical processes. The front pair are truncated cones, the summits alone being provided with spinnerules, but of three different sizes; one set very small near the interior edge, others of medium size near the centre, and one very large spinning tube on the inner margin. The middle pair of spinnerets are profusely furnished with very long spinnerules, amongst which are three very large ones near the centre and two at the upper part, with three or four of intermediate size. The hinder pair are provided with spinnerules on the summits and sides, and have, each, four of the larger kind, one low down, and the other three, together, towards the top. Careful observation of the spider at work seems to show that the front spinnerets are used for attaching and forming the guy lines and radial threads of the web; the small spinnerules forming the looped attachments and the filaments from the medium spinnerules coalescing around the thread from the large spinning tube; while from the small spinnerules of the hind pair proceed the broad bands of web with which the spider's victim is swathed; the four larger ones probably yielding the strong cords by which the prey is dragged along. The central pair are probably employed in furnishing the dotted spiral lines.

The points referred to, and the varying forms of proboscis in different flies, were illustrated by mounts in jelly in deep cells.

Soirée of the Reading Microscopical Society.

On the 15th of October the members of this Society, which is now in its eighth year of existence, gave their fourth soirée in the spacious and handsome town-hall.

On this occasion some thirty microscopes belonging to the members were placed on tables down each side of the hall, leaving ample space for the company in the centre of the really noble room. Though nothing very novel was exhibited, the objects were generally well selected and of an interesting character, and many of them, prepared by the members themselves, were, to say the least of it, equal to those of the best professional mounters. Mr. Baker, of High Holborn, also sent down a collection of fine instruments, which were most ably and courteously exhibited by Mr. Curteis, who had come down for the occasion. Mr. Curteis exhibited a beautiful set of micro-photographs, including those of our own countryman, Dr. Maddox, and those rarer and less-known American ones, done under the auspices of the War Department of that Government, showing the podura scale and the various pleurosigmæ as they appear under the 50th objective and amplifier; but perhaps, as specimens of local talent, the beautiful drawings of Messrs. Tatem and Clayton were the gems of the Exhibition. The delineations of infusorial life by the former gentleman were perfect of their kind, whilst Mr. Clayton's entomostraca, &c., allowing more scope for artistic treatment and colouring, formed perhaps the greatest attraction in the room. This gentleman also showed some entomostraca mounted in a particular medium of his own, in which they appeared to great advantage.

In the course of the evening the President, Capt. Lang, at the request of the visitors, made a few extempore observations. Remarking that an address formed no part of the programme of the evening, he called attention to the fine collection of instruments sent down by Mr. Baker, and to the objects so well shown under them by Mr. Curteis. He excused himself from making a long address, observing that microscopy is not a science in itself, but merely the handmaid of many sciences, and that a lecture on any special science would be out of place. Hoping that the number of working microscopists would increase in Reading, he expressed his surprise that more ladies did not enter upon the study for which they were so peculiarly adapted, as their delicate fairy-like fingers were exactly suited to the manipulation of both instruments and objects, whilst the pursuit would give a fresh interest to their country walks in the collection of objects; and he ended his appeal to them by pointing out how in the observation of the delicate tracery and beautiful patterns of minute organisms, only visible under the microscope, they would be constantly obtaining fresh and invaluable hints for their crotchet and embroidery work.

The company, after spending a pleasant evening, and partaking of the refreshments provided for them in the Council Chamber, separated about half-past ten o'clock.

Quekett Microscopical Club.

At the ordinary meeting, held at University College, November 27th, Arthur E. Durham, Esq., F.L.S., &c., President, in the chair, six new members were elected; sixteen gentlemen were proposed for membership; 173 slides were presented to the cabinet, and a number of presents to the library were announced. In pursuance of notice previously given, the meeting was then declared special for the consideration of the following proposition:—"That any member desirous of compounding for his future annual subscriptions may do so at any time by payment of 10*l.*; all such sums to be duly invested in such manner as the committee shall think fit." Upon being put from the chair, the resolution was declared to be carried unanimously, and was accordingly added to the bye-laws. The Secretary communicated the information that a microscopical society upon a similar basis to that of the Quekett Club had been recently established in Liverpool: he had been in correspondence with its promoters, affording them such information as they requested, and had since heard that a preliminary meeting had been held, at which fifty-eight members were enrolled. A paper by Mr. J. G. Tatem, of Reading, "On a new Melicertian, and on Melicerta Ringens," was read by Mr. T. Curties, the subject being illustrated by several beautifully executed coloured drawings. Some criticisms upon the paper were afterwards offered by Mr. Davis, and votes of thanks to the author and reader were unanimously passed. A highly interesting and valuable paper was also read by Mr. Lowne, "On the Proboscis of the Blow Fly," in which he detailed the results of a long series of careful observations upon the structure and functions of this remarkable organ, and illustrated his remarks by a series of excellent diagrams. The paper, which was listened to throughout with marked attention, elicited a hearty burst of applause from the members present, and a vote of thanks to the author was carried by acclamation. Some additional remarks upon the subject were made by Mr. W. T. Suffolk, and a short discussion ensued, in which Messrs. Breese, Lowne, Suffolk, and the President took part. The President announced that it had been in contemplation to hold an extra meeting in each month during the winter season, chiefly for conversational purposes and social re-union, so as to take the place in some measure of the summer excursions. By the very great courtesy of the Council of University College, facilities had been afforded for these meetings to be held on the second Friday evening in each month from December to March, and a committee of six persons was appointed to carry out the necessary arrangements.

Mr. N. Burgess exhibited and described a new and convenient form of collecting case, recently brought out by Mr. Stanley; and the proceedings of the evening terminated with a converzatione, at which a number of objects of interest were exhibited.

The first of the conversational meetings above referred to was held at the College, on December 11th, and was considered by all who were present to have been highly successful. Upwards of sixy members attended during the evening, and numerous interesting objects were exhibited under fifteen microscopes.

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THE

MONTHLY MICROSCOPICAL JOURNAL.

FEBRUARY 1, 1869.

I.—*On the Classification and Arrangement of Microscopic Objects.* By JAMES MURIE, M.D., F.L.S., &c., Prosector to the Zoological Society.

(*Read before the Royal Microscopical Society, March* 11, 1868.)

CONTENTS.

1. *Introductory.*—Pursuant to the request of my friends Dr. John Millar and Mr. Henry Lee, I have been induced to lay before this Society the present paper. The above-mentioned gentlemen as well as others, I presume, have found a difficulty in arranging satisfactorily their own miscellaneous microscopic objects—at least in what I may term scientific order.

In the year 1864 I undertook and completed a re-arrangement and weeding of the entire microscopical collection (some 16,000 in number) of the Royal College of Surgeons. This labour taught me to grapple with some of the difficulties usually encountered in systematizing microscopic objects for useful purposes.

At the outset I may incidentally remark that microscopic study is not limited to beauty of form in diminutive objects or perfection in optical apparatus; microscopy is rather the nucleus which, as it shoots outwards, entwines among all the sciences dealing with organized form. Frequently it is the range of subject and material which confuses the collector, and prevents his clearly appreciating the definite aim of an extensive miscellaneous series. The value of a large collection is decreased in the ratio of its magnitude and diversity of character, where, for want of a proper system, an object cannot at once be laid hands on, or a fresh one readily find its place.

The present communication, although containing no original research, may nevertheless prove of use, by calling attention to

some points practically bearing on microscopical science; at all events, it may be accepted as a tribute to the labours of your late distinguished President, Professor John Quekett. To himself and to his collections I am indebted for much information pertaining to minute organisms.

In discussing my topic, I have merely glanced at the efforts of the earlier observers to preserve specimens and classify them. Passing on, I then specify a few of the more important instances in which systematic classification has been adopted. Coming to Quekett's labours, I allude to his design in the formation of the superb collection at the College of Surgeons; and give an abstract of the series into which it is at present divided. Observations upon the principles of classification, cabinets, method of dividing, numbering, and labelling a collection, follow.

2. *Various Arrangements of Objects.*—Among the able microscopists who flourished during the seventeenth and eighteenth centuries, of whom such familiar names as Hooke, Grew, Leeuwenhoek, Lieberkühn, Baker, Adams, Swammerdam, Malpighi, Martin, Hewson, Trembley, Ellis, and Lyonnet, furnish brilliant examples; few, if any, seemed to have grasped the idea of the preservation of an extensive and classified series of minute objects. The improvement of the microscope itself formed one of the great aims of many of the earlier workers. But they did not lend themselves entirely to this latter, as the above list shows; for more careful observers and faithful delineators of all sorts of natural objects than some of those men could not be desired.

Although none, according to our present notions, formed a very large collection, yet, so to speak, their investigations foreshadowed, and indeed, in one instance, the identical microscopical specimens* (those of the acute physiologist, Hewson) have formed the nucleus of the most extensive modern histological cabinet. Of Hewson's preparations, I shall take note further on. Here, as an example of the nature and grouping of miscellaneous objects for the microscope of one of the earliest histologists, I quote Professor Harting,† of Utrecht, who gives a list of the sale catalogue with Leeuwenhoek's microscope.

ANIMAL OBJECTS.

Muscular fibres of a Whale.	Crystalline Lens of an Ox.
" " Cod Fish.	Blood Corpuscles of Man.
" " Duck's heart.	Liver of a Calf.
Transverse section of a Fish's muscles.	Transverse section of a Bladder.
	Urinary Bladder of an Ox.
Cuticle of Man.	Tongue papillæ of an Ox.

* See Preface to the 'Histological Catalogue, College of Surgeons,' vol. i.

† 'Das Microscop.' Theorie, Gebrauch, Geschichte, und Gegenwärtiger Zustand desselben. Translated from the Dutch into German by Fr. W. Theile. Pp. 918–19 (Braunschweig, 1859).

ANIMAL OBJECTS—*continued.*

Hair of Sheep.
,, Beaver.
,, Moose Deer.
,, Bear.
,, out of the Nose.
Scale of a Perch.
,, ,, Plaice.
Spinning Apparatus of a Spider.
Thread of a Spider.
Spider's Claw.
Teeth of a Spider.
Eye of a Spider.
Spinning Apparatus of a Silkworm.
Brain of a Fly.
Nerve Tendon (Nervure?) of a Fly.
Feet of a Fly.
Hooklets and Neck of a Flea.
Feet of a Flea.
Eye of *Aeschna grandis.*
,, Beetle.
Hooklets of a Louse.
Skin of a Louse.
Spine of the Leg of a Louse.
Red Coral.
Section of an Oyster Shell.
An oyster not yet fully developed, in a small tube.

VEGETABLE OBJECTS.

Trans. and Long. Sects. of Elm wood.
,, ,, ,, Pine wood.
,, ,, ,, Ebony.
,, ,, ,, Lime.
,, ,, ,, Oak.
,, ,, ,, Cinnamon.
Trans. and Long. Sects. of Cork.
,, ,, ,, Rushes.
,, ,, ,, Fossil wood.
,, ,, ,, Seeds Ergot of Rye.
Vascular bundles, Nutmeg.

MINERALS.

Portions of Marble. Rock Crystal. Diamond.
Gold Leaf. Gold-dust. Silver Ore. Saltpetre, &c.

After dwelling on the merits of the first workers and improvers of the microscope, Quekett remarks:* "A blank now occurs in the pages of microscopic history from 1784 until 1800." I may add thenceforth, from the latter date, histology again began to obtain the singular pre-eminence accorded it when illumined by the previously-mentioned galaxy of talented workers.

F. X. Bichat (1801), H. Dutrochet (1824), Bory de St. Vincent (1826), C. G. Ehrenberg (1828–30), and C. Th. Schwann (1838), may be cited as profitably employing the microscope in their physiological, botanical, and zoological researches. They as well as others, however, while laying a foundation for a true classification of textures and systematizing of microscopic organisms, did not anticipate the coming want of collections of microscopic preparations, derived from all substances.

The formation of the Microscopical Society of London in 1840, gave an impetus to the study of histology in this country, which for a long time had been neglected.

We see a fair start made in the preparing of specimens for cabinets, and attempts at grouping diversified substances in Pritchard's 'Microscopic Objects,' published in 1847. Therein is

* 'A Practical Treatise on the Use of the Microscope,' p. 34 (London, 1848).

a catalogue list of some 2000 objects, which are divided as follows:—

ORGANIC OBJECTS.

ANIMAL.

Anatomical Preparations.	Infusoria—Fossil.
Antennæ.	Larvæ—Insects.
Blood.	Followed by Sundries under the letters L, M, N, O, and P.
Bone (and Sundries).	Proboscis—Insects.
Eggs—Insects.	Followed by Respiratory System, &c.
Elytra ,,	Scales—Fish.
Exuviæ ,,	,, Insects.
Eyes—Fish.	Shell.
,, compound (Insects).	Skin.
Feet—Insects.	Teeth.
Fossils (and sundries under F and G).	Wings—Insects.
Hairs (animals, &c.).	Zoophytes.
Heads—Insects.	
Infusoria—Recent.	

VEGETABLE.

ORGANS.—*A. Simple.*

1. Cellular Tissue.	2. Vascular Tissue.
Fibre cellular.	*a.* Spiral vessels, simple.
Membrane with fibre.	*b.* ,, ,, compound.
Membrane without fibre.	*c.* Annular ducts.
3. Woody fibre, simple.	*d.* Reticulated ducts.
,, ,, glandular.	*e.* Dotted ducts.
Raphides.	

B. Compound.

Cuticles.

Flours.	Charcoal.	Petals.
Hairs.	Ferns.	Seeds.
Pollen.	Fossils (Woods).	Spores.
Algæ.	Fungi.	Starch.
Ashes (of Plants).	Grasses.	Woods.
Active Molecules.	Lichens.	,, fossil.
Bituminous.	Mosses.	Organic fabrics.

INORGANIC OBJECTS.

Crystals.	Chemicals without a heading except Crystals and Minerals for polarizing Microscope.
Iron, Steel, &c.	
Oolites.	

Works of Art.

In his excellent 'Practical Treatise,' already adverted to, Professor Quekett has devoted an entire chapter * to the "Classification of the most important Microscopical Objects." His intention in it, however, has not so much been a broad philosophical and

* Page 366, &c., and 3rd Ed., 1855, pp. 429 to 489.

microscopical classification of inorganic and organized nature, as a series of classified lists adaptable to any one desirous of obtaining knowledge of the most interesting objects, prepared by the manufacturers generally.

The several lists themselves are little better than those already mentioned by Mr. Pritchard, and like them each subdivision is arranged alphabetically. The lists of Quekett, over and above, have this advantage, that each section is introduced by most useful practical remarks as to the method of obtaining and preparing the tissues, objects, &c.

The main divisions are into:—Vegetable Tissues, and Animal Tissues—with a sub-section, Objects for Polarized Light.

Under I. Vegetable Tissues are found:—

Cuticles.	Hard Tissues.
Siliceous Cuticles.	Algæ.
Hairs.	Siliceous skeletons of recent and fossil Diatomaceæ.
Cellular Tissue.	Mosses.
Contents of Cells.	Ferns.
Colouring matter.	Spores.
Starch.	Pollen.
Raphides.	Seeds.
Spiral vessels.	Miscellaneous Structures of a fibrous character.
Ducts of various kinds.	
Woody Fibres.	
Fossil Woods.	

Under II., Animal Tissues, come:—

Sponges.	Hairs of Insects, &c.
Alcyonium.	Parts about the mouth of Insects, &c.
Gorgonia.	Parasitic Insects.
Corals.	Scales of Insects.
Zoophytes.	Spiracles and Tracheæ of Insects.
Insects.	Stings.
Eyes of Insects, Crustacea and Arachnida.	Stomachs.
Feet of Insects, &c.	

Preparations from the Higher Animals:—

Blood.	Shell.	Eyes.
Bone.	Scales of Fishes.	Muscular Fibre.
Teeth.	Hairs and Horns.	Mucous Membrane.
Fossil Teeth.	Skins.	

Among the objects for Polarized Light are short lists of animal, vegetable, and mineral productions.

I may, in passing, notice Quekett's 'Lectures on Histology' (1850–54), which embrace very good divisions of the elementary tissues and skeletal structures of plants and animals up to the vertebrata. As his histological catalogue and specimens in the

College Museum, however, embody the practical arrangement of specimens, I need not dwell further on the 'Lectures.'

Dr. John Millar has been good enough to place in my hands two catalogues of objects bearing upon the subject under consideration, and, as I believe they are little known in this country, I think this a fitting place to draw attention to them. They are entitled, *Description de cent Préparations Microscopiques, tirées des deux règnes et publiées par Institut Microscopique de Engell et Comp. à Wabern, près Berne* (*Suisse*). 1855.

The first part or section comes under the sub-heading, *Règne Animal, première Série. 25 Préparations provenant des protozaires, des rayonnés et des vers.*

This contains an introduction by Professor Oken, and also some prefatory words by Professor C. Vogt, of Geneva. Then follows a description of some twenty-five specimens, mounted in slides and numbered seriatim.

The classification adopted is:—

		Preparations.	
I.	*Animaux primordiaux, ou protozoaires* ..	= 4	= 25
	Eponges au Spongiaires	= 5	
II.	*Rayonnés*	= 11	
III.	*Les Vers*	= 2	
	Les Bryozoaires	= 3	

The second part contains, *Règne Animal, Deuxième Série. 25 Préparations provenant des mollusques, des articules, et des vertébrés.*

		Preparations.	
IV.	*Mollusques*	= 5	= 25
V.	*Artropodes ou Articulés*	= 12	
VI.	*Vertébrés*:—		
	Peau et écailles d'un poisson	= 1	
	Poils et coupes transversales de poils	= 3	
	Coupe d'os	= 1	
	Globules sanguins	= 1	
	Injections de vaisseaux sanguins	= 2	
	Les Reins.		
	Les Poumons.		
	Le Foie.		
	Intestines.		

Each group is prefaced by some general remarks, preparing, as it were, the student to comprehend the several preparations classed under it. I am in ignorance if two succeeding parts of the catalogue have ever been published.

Dr. W. B. Carpenter is among those who have done much towards the diffusion of educational and sound scientific histological knowledge in this country. His volume on 'The Microscope and its Revelations' (1857, and 4th Ed., 1868), while not professing to give any elaborate philosophical arrangement, yet comprehends

such an extensive histological range as to be very appropriate in illustration of the topic under discussion.

The subjoined table presents his analytic division in the order in which he treats his subject:—

MICROSCOPIC FORMS OF VEGETABLE LIFE—PROTOPHYTES.

Volvocineæ.	Ulvaceæ.	Conjugateæ.
Desmideaceæ.	Ocillatoriaceæ.	Chætophoraceæ.
Pediastreæ.	Nostochaceæ.	Batrachospermeæ.
Diatomaceæ.	Siphonaceæ.	Characeæ.
Palmellaceæ.	Confervaceæ.	

HIGHER CRYPTOGAMIA.

Algæ.	Hepaticæ.	Ferns.
Lichens.	Mosses.	Equisitaceæ.
Fungi.		

Of this series the general structure and fructification form the subdivisions.

PHANEROGAMIC PLANTS.

Elementary Tissues.	Cuticle.	Flowers.
Structure of Stem and Root.	Leaves.	Seeds.

MICROSCOPIC FORMS OF ANIMAL LIFE.—PROTOZOA.—ANIMALCULES.

Protozoa.	Lobosa.	Thalassicollida.
Rhizopoda.	Reproduction of Rhizopoda.	Animalcules.
Reticularia.	Gregarinidæ.	Infusoria.
Radiolaria.		Rotifera.

FORAMINIFERA, POLYCYSTINA, AND SPONGES.

Foraminifera.	Globigerinida.	Porifera (Sponges),
Miliolida.	Nummulinida.	Skeleton. Reproduction.
Lituolida.	Polycystina.	
Lagenida.	Acanthometrina.	

ZOOPHYTES.

Hydra.	Hydrozoa.	Acalephæ.	Anthozoa.

ECHINODERMATA.

Structure of Skeleton.	Echinoderm—Larvæ.

POLYZOA. TUNICATA.

MOLLUSCA.

Shells of Mollusca.	Ciliary Motion on Gills.
Tongue of Gasteropods.	Organs of Sense of Mollusks.
Development of Mollusca.	Chromatophores of Cephalapods.

ANNULOSA OR WORMS.

Entozoa.	Turbellaria.	Annelida.

CRUSTACEA.

Pycnogonidæ.	Cirrhipeda.
Entomostraca.	Shell of Decapoda.
Suctoria.	Metamorphosis of Decapoda.

INSECTS AND ARACHNIDA.

Structure of Integument.	Circulation of Blood.
Tegumentary Appendages.	Respiratory Apparatus.
Eyes.	Wings. Feet.
Antennæ.	Stings and Ovipositors.
Mouth.	Eggs.

AGAMIC REPRODUCTION.

Acarida.	Parts of Spiders.

VERTEBRATED ANIMALS.

Elementary Tissues.	Epidermis.
Bone.	Pigment Cells.
Teeth.	Epithelium.
Scales of Fish.	Fat.
Hairs.	Cartilage.
Feathers.	Glands.
Horns, Hoof, &c.	Muscle.
Blood.	Nerve.
White and Yellow Fibres.	Circulation of the Blood.
Skin, Mucous and Serous Membranes.	Injected preparations.
	Vessels of Respiratory Organs.

APPLICATION OF THE MICROSCOPE TO GEOLOGY.

Fossilized Wood, Coal.	Structure of Fossil Bones, Teeth, &c.
Fossil Foraminifera, Chalk.	Inorganic Materials of Rocks.
Organic Materials of Rocks.	

INORGANIC OR MINERAL KINGDOM.—POLARIZATION.

Mineral Objects.	Organic Structures suitable for Polariscope.
Crystallization of Salts.	Micro-Chemistry.
Molecular Coalescence.	

In the 'Catalogue of Microscopic Objects' in the cabinet of your own Society, published in 1864, the preface states that, "What was proposed, and has been attempted, is—avoiding any attempt at scientific arrangement—to provide an index to the slides, with their titles, as nearly as possible, in alphabetical order. The exceptions to a strict adherence to this order are:—

"1. Some groups of objects are entered under a common head, as *Diatomaceæ*, *Shell*, *Wood*, and a few others.

"2. The slides of a *series presented* are entered as numbered when received, though in adhering to that arrangement the alphabetical order of the titles is disregarded; thus, under the title *Shell*, the series of slides (illustrating its structure) presented by Dr. W. B. Carpenter are entered as numbered, his arrangement (for which there were no doubt good grounds) being preserved."

Then follows some remarks on the Diatoms which are grouped alphabetically as α.—species; β.—locality; γ.—sundries.

There was a Microscopic Soirée given by the Bath and Bristol Microscopic Societies during the meeting of the British Association at Bath in 1864. The synopsis issued on that occasion is so

remarkable for the clear and succinct mode of arrangement, that, in justice to the above societies, I must draw special attention to it.

A note of introduction states that "the classification of the animal kingdom adopted in the synopsis is that of Professor Huxley (*see* 'Jukes' Geology')."

The following exhibits analytically the arrangement of the series of objects shown during that evening, 20th September, 1864.

VEGETABLE KINGDOM.

Vegetable Cell and Cell Contents.

Thallogens.	*Acrogens.*	*Endogens.*	*Exogens.*
Algæ.	Hepaticæ.	.. ..	.. ..
Fungi and Lichens.	Musci.	.. ..	.. ..
.. ..	Lycopodiaceæ.	.. ..	.. ..
.. ..	Equisetaceæ.	.. ..	.. ..
.. ..	Filices.	.. ..	.. ..

ANIMAL KINGDOM.

Protozoa.	*Mollusca.*	*Annulosa.*
Rhizopoda.	Polyzoa.	Echinodermata.
Spongidae.	Brachiopoda.	Scolecida.
Infusoria.	Conchifera.	Annelida.
	Gasteropoda.	Crustacea.
Cœlenterata.	Cephalopoda.	Arachnida.
Hydrozoa.		Myriapoda.
Actinozoa.		Insecta.

Histology and 'General' Anatomy of the Vertebrata.

Bone System.	Integumentary System.
Muscular and Fibrous System.	Nutritive System.
Nervous System and Organs of Sense.	Miscellanea.

GEOLOGY.

Microzoal Deposits.

From the Crag.	From the Lias, Trias.
" Pleiocene.	" Carboniferous.
" Eocene.	" Devonian.
" Chalk and Green Sand.	" Silurian.
" Upper and Inferior Oolite.	

Besides the above, from special mentioned geological formations, there were fossil specimens and sections from the Invertebrate and Vertebrate kingdoms, Fossil-wood, Coal, &c.

CHEMISTRY.

Micro-goniometers. Crystallization.

Chemical Crystalline preparations :—

Vegetable Alkaloids.	Salts.
Sublimations.	Adulterations.

MINERALOGY.

Sections of Minerals. Crystalline Minerals. Native Metals.

It would be an invidious task for me to point out, among the various synoptical lists and catalogues issued by the numerous manufacturers of microscopes and microscopic specimens, those meriting commendation as regards the arrangement adopted. Some I find are curt business-like circulars, others aspire to a very complete arrangement of the objects, grouping them, however, under such heads as already have been referred to when speaking of Quekett's 'Treatise on the Microscope.'

I purposely avoid lengthened remarks on the many divisions and subdivisions of textures, to be found in the numerous and often excellent works devoted to special departments of histology. My aim has rather been to quote a few of such published lists as indicate in a general way practical grouping of series of objects of a varied character for cabinets. Such indeed as might be found in any ordinary miscellaneous collection. Thus of literature of the former class I may instance Kölliker's '*Handbuch der Gewebelehre*,' the English translation of which ('Manual of Human Microscopic Anatomy,' 1860) in the contents affords a model of classification, textural and organal, of the histology of man. In the same way, I might refer to treatises on Botany, on the Lower Forms of Animal Life, on Entomology, on the Teeth, &c., &c., but this I fear would more confuse by multiplicity of detail than lend effectual aid in the systematic distribution of specimens among which there might not be a slide representative of the theoretic outline. As a rule, however, the minor subdivisions of writers on special branches may be advantageously employed were there sufficient examples to carry out the grouping effectually.

What British and few Continental collections of microscopical preparations I have had the opportunity of inspecting, have appeared to me defective in arrangement; unless where the objects were limited to illustration of a single department. From these latter, however, one may learn a lesson and build together material of different kinds. For example, my friend Mr. David Forbes has a rich microscopical collection of sections of rocks and minerals, and which he has placed together on sound geological principles.*

The British Museum, that badly displayed but nevertheless rich treasury of natural objects, possesses a good series of Diatomaceæ, many type specimens; and these, thanks to the untiring zeal of Mr. W. Carruthers, are carefully labelled and systematically catalogued† according to a modification of Kützing's Genera.

Lastly, in this section of my paper, I have much pleasure in referring to the recent labours of my kinsmen in America. As the

* See his paper on "The Microscope in Geology," 'Popular Science Review,' Oct. 1867.

† 'Handbook of British Water-weeds; or, Algæ.' By Dr. J. E. Gray, the *Diatomaceæ by W. Carruthers.* Lond. 1864.

din of civil war has ceased, the more agreeable note reaches us that science there has not been forgotten; but rather received an impulse from what otherwise might be supposed to have thwarted it, for years to come. In the Catalogue of the Microscopical Section of the United States' Army Medical Museum (Washington, 1867), we have an admirable proof of how much can be achieved by zealous and practical workers in a short space of time. Some 2120 specimens, well classified and succinctly catalogued already, are in the cabinet of the above Museum.

The arrangement chosen, as might be expected, is a physiological one.

Part I.—Contains a series of elementary tissues, followed by systems and organs. Each section is further subdivided into specimens from man, from animals, and pathological conditions. Pathological growths (tumours) of themselves form a group equivalent to organs. Parasites the same. Articles of food and clothing, and Materia Medica another. Diatoms and other test objects still another, and, lastly, miscellaneous objects.

Part II.—Devoted to photographic negatives of microscopic objects, has the same number of subsidiary divisions as the above.

Part III.—Is a series of photomicrographs presented to the Museum.

Strictly speaking, the foregoing comprises a speciality, and is not illustrative of the arrangement of general or miscellaneous substances; yet, as it points to well directed efforts towards the establishment of consulting and teaching microscopical collections, consistently classified, it merits attention.

3. *Microscopic Collection, College of Surgeons.*—An innate love of nature and partiality for her minute workings, was a ruling passion with John Quekett from a lad onwards in life. Hardly had he got a footing at the Hunterian Museum ere he pursued vigorously those researches he had already commenced as a student. These the earlier numbers of the 'Microscopical Society's Transactions' bear witness to. But soon the breadth of his views concerning minute texture developed themselves in the founding of a series of preparations equivalent to, and in some respects corresponding with, those of the immortal John Hunter. His intention, as he has personally informed me, was to amass histological material illustrative of nature in its widest acceptation. Thus not only to represent substances in their healthy condition, but also in their pathological changes, in their development, and as applied to useful purposes. He had already published two volumes,* and had others

* Descriptive and Illustrated Catalogue of the Histological Series contained in the Museum of the Royal College of Surgeons of England. Vol. I. Elementary Tissues of Vegetables and Animals, 1850. Vol. II. Structure of Skeleton of Vertebrate Animals, 1855.

in preparation, of his extensive catalogue, when, alas! death snatched him off too soon to finish the good work. The catalogued specimens were left in perfect order. Excepting partly in the case of the series of teeth, which would have formed volume III.; the remainder were somewhat irregularly distributed in the cabinets, though more or less under special headings, such as R.B., Respiratory System of Birds; T.A., Organ of Taste; M., Muscular System, and so on. To those so numbered (chiefly physiological specimens) notes regarding them were extant; but many others had only the name of the object or donor appended. A considerable proportion of the slides had become unsatisfactory in condition, were duplicates, or were unfit to be kept as permanent objects.

In this state of things the Council deputed me (having formerly been Prof. Quekett's assistant) to put the whole in better order. After overhauling the entire series, I rejected some 4000, and then repaired, classified, and numbered consecutively the remainder (about some 12,000) in groups, which the following tables exemplify. Knowing somewhat the purport of Quekett's intended future design, I endeavoured to fulfil his ideas, in so far as mere arrangement was concerned, and to make his microscopical series exponent of John Hunter's specimens. Hence the Physiological Series is followed by a Pathological one, and that by a division of Natural History. Moreover, the nature and quantity of objects necessarily caused the formation of the last-mentioned section.

Judging critically of the total series as it at present stands, I would say it has many short-comings, and is not precisely applicable to microscopical collections of smaller compass. On the other hand, the arrangement has advantages, if viewed merely as histologically expressive of the Hunterian preparations and specimens. Quekett's two volumes of elementary tissues, ending with the Skeleton, and the forward state of the Series on the Teeth, led insensibly to a succession of organs physiologically subdivided. Hewson's and Dr. Todd's sets of specimens could not well be incorporated under each object's proper heading, unless by weakening the respective value of each series. Pathology is but a rough outline, the minor divisions being only such as there were specimens to represent—and not at all a complete epitome of what ought to be. Whether Urinary deposits should not come under chemical constituents is an open question. Parasites and Entozoa are both found in the Pathological and Natural History divisions. Recent Woods, and again Fossil Woods, intermixed in separate series and differently classified, does not seem very satisfactory. Parasites under Insecta instead of Arachnida, is another of the anomalies. Each and all of these can only be defended on the grounds of *expediency*, as the nature of the series and the size of the slides,

&c., &c., best admitted of their distribution and position in the cabinets.

The Histological Series of the College of Surgeons is contained in two large mahogany cabinets, with double folding-doors. Each cabinet is divided into four vertical rows of drawers, with sixty-three drawers in every row. The drawers themselves are subdivided into four compartments, each of which holds eleven slides, 3 inches by 1 inch in size. The lowest drawer in all the rows is extra deep, namely, includes two ordinary drawers; in these more than usually deep-celled preparations are kept. Cabinet No. 1 is devoted to the Physiological and Pathological Series; cabinet No. 2 includes the Natural History Series. The main grouping follows the order of the succeeding tables; but these, it is to be noted, do not embrace every minor subdivision, as this would have involved too great an extension of what is already long enough. The manner of numbering, labelling, &c., shall be discussed as I proceed farther on.

Vol. I. Histological Catalogue. Elementary Tissues of Plants and Animals.

PHYSIOLOGICAL SERIES.

Histology of Vegetables.

Series.—Membrane. Fibre.
,, Cellular Tissue, or Parenchym, containing various forms of Cells, Starch, and Raphides.
,, Fibro-cellular Tissue. Pitted Tissue. Porous Tissue, or Bothrenchym.
,, Woody Tissue, or Pleurenchym.
,, Vascular Tissue, or Trachenchym .. .. .. { Subseries.—Annular, Reticulated and Scalariform, vessels and Ducts.
,, Lacticiferous Tissue, or Cinenchym. Hard Tissue.

Histology of Animals.

,, Simple Membrane. Fibrous Tissues.
,, Areolar Tissues.
,, Cellular Tissues { Subseries—Membraniform Cartilage.
 ,, Articular Cartilage.
 ,, Vessels of Membraniform Cartilage.
 ,, Vessels of Articular Cartilage.
,, Cellular Tissues.—Adipose Tissue and Fat.
 Subseries—Vessels of Adipose Tissue.
,, Cellular Tissues.—Pigment.
,, Sclerous, or Hard Tissues. { Subseries.—Structure of the Skeleton of Vegetables.
 ,, Skeletons of Animals. Sponges.
 ,, ,, Diatomaceæ and Infusoria.
 ,, ,, Zoophytes. Polypipheræ.
 ,, ,, Acalephæ.
 ,, ,, Echinodermata.
 ,, ,, Insects.
 ,, ,, Crustacea.
 ,, ,, Annelida.
 ,, ,, Cirropoda.
 ,, ,, Mollusca.
 ,, Structure of Pearls.

Vol. II. Histol. Cat. Structure of the Skeleton of Vertebrate Animals.

Subseries.—Endo-Skeleton of Fishes.
„ Exo-Skeleton of Fishes.
„ Endo-Skeleton of Reptiles.
„ Endo-Skeleton of Birds.
„ Splachno-Skeleton of Birds.
„ Endo-Skeleton of Mammalia, with several subsidiary divisions. Deciduons and Persistent Appendages of Ruminants, &c.
„ Exo-Skeleton of Mammalia.
„ Splachno-Skeleton of Mammalia.

For the many subdivisions of the elementary tissues adopted by Professor Quekett, and not included in the above synopsis, I must refer the reader to the published volumes.

Vol. III., Histological Catalogue. Unpublished.

STRUCTURE OF THE TEETH.

INVERTEBRATA.

Dental Organs, Leech, Snail, &c

VERTEBRATA.

TEETH OF FISHES.

Series arranged chiefly according to complexity of composition.

TEETH OF REPTILES.

Icthyo Batrachia.	*Ophidia.*	*Crocodilia.*
Batrachia.	*Lacertilia.*	*Enalosauria.*

TEETH OF MAMMALIA.

Monotremata.	*Bruta.*	*Ruminantia.*
Marsupialia.	*Cetacea.*	*Carnivora.*
Rodentia.	*Proboscidia.*	*Quadrumana.*
Insectivora.	*Perrisodactyla.*	*Bimana* = Man.
Cheiroptera.	*Artiodactyla.*	

Subseries — Specimens chiefly consisting of and illustrating Mr. Nasmyth's 'Researches on the Teeth.'

Fragments of Teeth showing Dentine.	*Teeth and Alveolus.*
„ „ *Enamel.*	*Temporary Teeth.*
„ „ *various conditions of Cementum.*	

DENTAL SAC AND PULP.

Ruminantia. *Carnivora, &c.* Man.

ORGANS OF DIGESTION.

The Mouth.	Glands of Oral Cavity.
The Tongue.	Pharynx and Œsophagus.
The Stomach.	Intestines.

Glands connected with Digestion.

The Liver.	Gall Bladder.
The Pancreas.	Spleen.

ORGANS OF RESPIRATION.

Tracheæ and Spiracles of Insects.	Branchia of Crustacea.
Gills of Fishes.	Air Bladder of Fishes.
Lungs.	Bronchi and Trachea.

Ductless Glands adjoining Trachea.

Thyroid Body.	Thymus Gland.

NERVOUS SYSTEM.

Invertebrata.

Vertebrata.

Spinal Cord. In Mammals generally.—In Man.
Brain " " "

Professor Lenhossek's Series of Preparations to illustrate the Structure of the Spinal Cord and Brain in Man. A descriptive Catalogue accompanies this series.

Membranes of the Brain:—Pia Mater. Choroid Plexus.
Structure of Nerves.

ORGANS OF THE SENSES.

Organ of Hearing. | *Organ of Smell.*

ORGAN OF VISION.

Sclerotica and Cornea. Choroid. Iris.
Retina. Crystalline Lens.

Accessory Organs of Vision.

The Eyelid. Nictitating Membrane. Meibomian Glands.
Lachrymal Gland.

EXTERNAL INTEGUMENT.

The Skin. Subseries Skin after process of Tanning.
Tegumentary Appendages:—Claw and Nail. Hair. Feathers. Horn. Hoof.

ORGANS OF CIRCULATION.

Blood Corpuscles in Invertebrates and Vertebrates.
Lymphatic Glands.
Blood Vessels. The Heart.

MUSCULAR SYSTEM AND JOINTS.

Muscle. Joints. Tendon and Ligament.

MEMBRANES, &c.

Synovial Membrane.
Serous Membranes:—Pericardium. Pleura. Peritoneum.
Fat, &c.

URINARY ORGANS.

Kidney. Pelvis of Kidney and Ureter. Urinary Bladder.

Organs of Generation.

Male Organs.

Penis. Prostate Gland. Testis. Spermatozoa.

Female Organs.

External Organs. Uterus. Oviduct and Fallopian Tube.
Ovum. Egg.

Fœtal Envelopes.

Chorion. Alantois. Placenta.
Series various Fœtal Preparations.

Microscopic Specimens made by Hewson (1780), and purchased by John Hunter at the sale of Hewson's Museum.

Portions of Tissues preserved in Spirits and put up in Hermetically-sealed Glass Tubes.

Portions of Tissues injected and put on Glass Slides and Dried.

Muscle. Intestine. Lung. Brain. Eye.
Kidney. Fœtal Membranes.

Dr. Todd's (of Brighton) Series of Specimens illustrating Physiological Processes—Inflammation, Repair, &c.

Punctured Wounds (Web of Frog's foot).
Contused ,, (,,).
Process of Sloughing (,,).
Healing by Granulation (Portion web of Frog's foot excised by a punch).
,, First Intention (Arteries in Frog's foot).
,, ,, (Veins ,,).

Regeneration of Tail, Larva of Newt.
,, ,, Subseries, when tail allowed to grow 17 days.
Second Regeneration Tail of Newt.
(Tail cut off, parts suffered to grow for 32 days, when it was a second time excised.)
Third Regeneration of Tail of Newt.
(Tail cut off, parts suffered to grow for 32 days, when it was a second time excised; again allowed to grow 20 days, it was cut off for the third time.)
Regeneration Leg and Foot of Newt.
Another Series of same.
Another Series Regeneration Tail of Newt.
Regeneration in a Worm.
A similar Series, but each species dried and put in a cell.
Regeneration Head of Worm.
,, Tail of Worm.
Another short Series Regeneration of Worm.
Series of Sections illustrating Process of Regeneration.
Metamorphosis of Tadpole.

Series of Specimens also prepared by Dr. Todd, of Brighton, illustrating Pathology.

These preparations have not been incorporated with the subjoined Pathological Series—1st, so as to keep Dr. Todd's series

together; and secondly, because being on small slides, they better fit the altered divisions of the drawers.

PATHOLOGICAL SERIES.

Abnormal Textures in General.

New Formations—Tumours, &c.

Diseases of the Osseous System.

Repair of Injuries of Bone.
Tumour of Bone.
Hypertrophy Bones of Cranium.
Osseous Deposit in Long Bones, &c.
Ulceration of Bone.
Caries and Necrosis.
Fatty Degeneration, &c., of Bone.
Osseous Substance found in various Organs.

Diseases of the Teeth.

Caries or Decay.
Formation of Fine Bone in Teeth.
Exostosis.
Teeth detected in the Ovary.

Diseases of the Digestive Organs.

Mouth and Gullet.
Ulceration of Stomach, &c.

Intestines.

Hypertrophy. Ulceration.

Diseases of the Liver.

Diseases of the Spleen.

Diseases of the Organs of Respiration.

Lung. | Tuberculous deposit. | Enchondroma.

Diseases of the Nervous System.

Tubercles Membranes of Brain.

Diseases of the Organs of Vision.

EYE.

Series of Preparations made by Dr. Charles Bader, illustrating injuries and diseases of the eye, and Specimens described in Supplement II. of Pathological Catalogue of the Museum.

A. Morbid changes of the Eyeball, resulting from *Injury*.
B. " " " *Disease*.
C. New Growths originating in Tissues of the Eyeball or Orbit.

Diseases of the Skin.

Cicatrix. Ulcer and Abscess.

Diseases of the Organs of Circulation.

Lymph and Blood. Arteries. Veins.

Diseases of the Muscular System.

Fatty Degeneration.

Diseases of the Kidneys.

Diseases of the Joints.

Diseases of the Organs of Generation.

Penis. | Testicle. | Uterus.

Diseases of the Urinary Bladder.

URINARY DEPOSITS.

Uric Acid.	Cystine.	Carbonate of Lime.
Lithates.	Hippuric Acid.	Various Deposits.
Oxalate of Lime.	Triple Phosphate.	

Calculi.

Biliary Calculi. | Intestinal Calculi. | Urinary Calculi.

Parasites, &c. (chiefly found in the Human Body).

Plants. | Animals.

Entozoa.

Nematoida = Round Worms.	Cestoida = Tape Worms.
Trematoda = Suction Worms.	Cystica = Vesicular Worms.

Various Foreign Bodies said to be passed from the Human Body.

NATURAL HISTORY SERIES.

THE MINERAL KINGDOM.

Chemical Elements.	Crystalline Salts.
Acids in Crystalline Form.	Alkaloids.

MINERALS.

Of various kinds. | Series of Coprolites, ranged here because Earthy.

STRUCTURE OF COAL.

Coal, English.	*Coal, South America.*
" *Welsh.*	" *Africa, & Islands in Atlantic.*
" *Scotch.*	" *China and Borneo.*
" *German.*	" *New Zealand.*
" *from Arctic Regions.*	" *Antarctic Regions.*
" *North America.*	" *Localities unrecorded.*
" *West Indies.*	

STRUCTURE OF LIGNITE.

English Lignites.	*America and Northern Latitudes.*
European Lignites.	

WOODS UNDERGOING BITUMENZATION.

Structure of Jet.	*Structure of the Torbane Mineral.*
Structure of Shale.	*Substances allied to Coal.*

VEGETABLE KINGDOM.

ORDER THALLOGENS—ALGÆ.

Order:—

DIATOMACEÆ.

Genera arranged seriatim according to Smith's 'Synop. Brit. Diatom.'
Earths containing Diatomaceæ, recent and Fossil.

English Infusorial Earths.	Germany, &c.
Scotch " "	Italy, &c.
Irish " "	North America.
Northern Europe "	West Indies.

Various Localities.

DESMIDEÆ.

Genera arranged according to Ralf's 'Brit. Desmid.'

CONFERVACEÆ.
FUCACEÆ.

CERAMIACEÆ	Various Genera. Sections, Corallines, and Nullipores.
CHARACEÆ.	
FUNGI	Fungi affecting the Grasses. " found on Shrubs, &c. Woods with fungi in their interior. Fungi growing upon Animals.

ORDER ACROGENS.

MUSCI, or Mosses ..	Various genera. Fructification.
LYCOPODIACEÆ.	
EQUISETACEÆ.	
POLYPODIACIÆ, or Ferns	Organs of Fructification. Root and Stem.

THE SKELETON OF PLANTS.

Series illustrating the Structure of the Root and Stem in various Orders of Plants. These contain both Recent and Fossil Specimens arranged into Orders and Genera according to Lindley's 'Vegetable Kingdom.'

WOODS OR STEM.

ORDER Endogens—Palms ..	Recent Fossil.	Geographical Distribution. Localities not known.
" Dictyogens.		
" Gymnogens—Cycads and Conifera.		
" Exogens	Families, genera, and species in ascending series.	

Series illustrating Stem of Climbing and Creeping Plants (species unknown).

FOSSIL WOODS.

These sections correspond to the Museum specimens; the numbers and arrangement being that of the printed Catalogue of the Fossil Department (Plants), where most of them are described.

Exogens. Gymnogens. Endogens. Acrogens.

Grouped according to families, and from various localities.

Series of Fossil Woods arranged according to Geographical Distribution.
" " Localities, &c., of which are unknown.

Further Series of *Recent Woods*—the genera, &c., unknown, but native names attached.

Of this last rather extensive series, the pieces of wood from which the microscopic specimen was cut are to be found in the

Museum. They answer to the Secondary list numbers, 15, 16, &c. Many of the woods were bought at the sale of the late Robert Brown's botanist effects, and others, at Stevens's auction rooms.

RESPIRATORY ORGAN.

The Leaf.

TEGUMENTARY ORGANS.

The Bark of Plants. The Cuticle.
The Epidermal Appendages—Scales, Hair, and Spines.

ORGANS OF GENERATION AND DEVELOPMENT.

Fructification in Plants.

The Flower Stem. The Flower. The Stamen and Anther. The Pollen.
The Fruit—Seed-vessel, Seed, Nuts, &c.
Series illustrating Vegetable Productions, &c.

ANIMAL KINGDOM.

INVERTEBRATA.

Order FORAMINIFERA	..	Families, Genera, and Species arranged seriatim.
" PORIFERA = Sponges	Living	Hard Skeleton. Spiculæ, &c.
		Soft " Fibre.
		Horny Frame-work.
		Series Fossil Sponges.
		Organs of Reproduction. The Gemmules.
" ANTHOZOA = Gorgonias		Calcareous Skeleton. Spicula.
		Horny Axis. Horny Stem.
" ACTINOZOA = Corals		Hard Skeleton, arranged according to Genera.
		Fleshy Body. Actinias, &c.
" BRYOZOA, OR POLYZOA		Arranged after Busk's Cat. Brit. Mus.
" ECHINODERMATA ..		Series small specimens put up whole.
		Skeleton. Stem of Encrinites, &c.
		Spines. Shell. Skin.
		Calcareous Skeleton Synapta. Ditto Holothuridæ. Organs of Digestion. Teeth. Jaws. Structure of various Organs.
" MOLLUSCA	The Hard Skeleton	Shells, according to Genera. Structure of Pearls.
	Organs of Digestion	Series Teeth, Tongue, and Palates.
" ENTOZOA		Cystica. Cestoidea. Nematoidea. Trematoda.
" ROTIFERA.		
" ANNELIDA		Dorsibranchiata.
		Abranchiata.
" MYRIAPODA.		

INSECTA.

Series of various genera to show General Structure:—

Skeleton of Insects. Integument of Beetles.
Integument in Organs of Flight: Wing.
Tegumentary Appendages: Scales. Integument and Appendages: Skin.
The Hair. The Antennæ.
The Head. Organs of Offence and Prehension.
Organs of Digestion: Tongue and Proboscis, and Palate, Stomach, Gizzard.
Organs of Respiration: Spiracles and Tracheæ.

Organs of Locomotion : Leg, Foot.
Organs of Sight: Eye. Organs of Defence, &c.
Organs of Generation.
Development of Insects: Egg. Undergoing Transformation.

Series illustrating their cast-off Integument. Insect productions:—
Parasitical Insects, those chiefly found on Plants.
Parasites found on Insects. Parasites found on Reptiles.
Parasites found on Birds. Parasites found on Mammalia.
Human Parasites.

CRUSTACEA.

Hard Skeleton. Tegumentary Structure. Organs of Locomotion : *Claw.*
Stomach and Eye of Crab. Structure Shell: Shrimp and Cray Fish.
Structure of Lobster: Shell. Organs of Locomotion: Claw.
Organ of Sight.

CIRRHIPEDIA { Hard Skeleton: *Barnacles.*
Structure of the Cirri.

ARACHNIDA: SPIDERS .. { Series (put up whole) arranged according to Genera.
Tegumentary Organs. Skin, Hair, &c.
Organs of Digestion, &c.
Organs of Locomotion: Foot.
Spider Productions: Web, &c.

II.—*Immersion Objectives and Test-objects.*

By John Mayall, jun., F.R.M.S., &c.

(*Read before the Royal Microscopical Society, October* 14, 1868.)

The presentation of Dr. Woodward's photographs of Nobert's Nineteen-band Test-plate, brought to the notice of the Society by the Hon. Secretary, Mr. Jabez Hogg, affords an opportunity of making a few remarks on their value as a record of what has been done in America in resolving these marvellously fine lines; and as in my experiments I found some difference in the results obtained on Nobert's plate by the immersion and the dry objectives, I think it will interest the Society to be informed of these results, because the relative separating and defining power of the two systems has not received that attention which I and many others think it deserves.

The only way we have of verifying the accuracy of the divisions of Nobert's Test-lines is by counting them in a measured space. For example: if 46 equidistant lines are ruled in the space of $\frac{1}{2000}$th of an inch, the interspaces must be at the rate of 90,000 to the inch, and so on. An error of one line more or less in counting the whole of the lines on such a band would decide the rate of the interspaces to be either 92,000 or 88,000, instead of 90,000 to the inch.

Dr. Woodward's photographs support an opinion given by Mr. Wenham many years ago, that the time would come when photography would reveal minute detail much more palpably than it can be seen in the microscope. The reason of this is obvious. In photography the object may be illuminated by highly condensed sun-light—a light producing the intensest black shadows, and quite unendurable to the eye—and it was with such illumination that these photographs were obtained. They may be accepted as showing true lines on all the bands to the fifteenth inclusive; but beyond this, they serve little purpose of verification. Repeated trials on the higher bands, as shown in the photographs, have convinced me that Dr. Woodward's counting includes or rejects such doubtful lines, that it cannot be accepted as exact evidence of the number of lines ruled on the plate. I think too that he underrates the difficulty of counting the lines. In all the bands beyond the twelfth, as I have seen them in the microscope, there is great difficulty to decide on the first and last lines. Dr. Woodward seems not to have been sure of the accuracy of the count he made on his photograph; for although in one part of his paper in the current (October) number of the Journal of this Society, he says the photograph shows the twelfth band as resolved

into *thirty-seven* lines, farther on he says that *forty* is the real number in that band.

It cannot be supposed that all the corresponding bands on different plates agree precisely in difficulty to resolve; it follows that a comparison of results obtained by two objectives, each tried on a different plate, may be very deceptive; though when tried on the same plate their relative separating power is at once decided.

It was only after frequent trials that I could be assured of distinguishing readily between the appearance of the true consecutive lines and those woolly or wavy-looking lines, which are shown either by defective illumination or by the want of power in the objective, but which are sometimes believed to be imperfectly ruled lines.

With the $\frac{1}{8}$th and the $\frac{1}{12}$th by Ross, and the $\frac{1}{20}$th by Smith, in the possession of this Society, and with a $\frac{1}{8}$th, a $\frac{1}{12}$th, a $\frac{1}{16}$th, and a $\frac{1}{25}$th by Powell and Lealand, all dry objectives (not to mention others which gave similar or inferior results), on a new nineteen-band plate, all the bands beyond the twelfth seemed imperfect—the lines were not separated.

But with a $\frac{1}{10}$th and a $\frac{1}{18}$th by Hartnack, of Paris, a $\frac{1}{16}$th by Merz, of Munich, and a $\frac{1}{20}$th by Nobert, all immersion objectives, straight and well-defined lines were separated as far as the fifteenth band inclusive. In the last four bands true consecutive lines were seen; but they are so extremely slightly ruled, that the eye fails to appreciate their increased fineness. I should expect that, if the lines in the twelfth band were as slightly ruled as those on the last four bands, there would be nearly the same difficulty in seeing them, notwithstanding their wider separation. If the lines were exposed to the incident light, without the interposition of any reflecting surface or refracting medium, they would, doubtless, be seen with much greater ease.

These results were the best I obtained by the dry and immersion objectives with the same method of artificial illumination. Several trials with sun-light proved that the lines were thus rendered more visible; but the immersion objectives maintained their superiority by all methods.

I can find no evidence whatever for the statement that the resolving of Test-diatoms and Nobert's Test-lines is merely a question of *angular aperture.* Ross's $\frac{1}{12}$th, Smith's $\frac{1}{20}$th, Powell and Lealand's $\frac{1}{12}$th, and $\frac{1}{16}$th dry objectives were all of larger aperture than Merz's $\frac{1}{16}$th Immersion, yet neither gave as good results on *Surirella gemma, Frustulia Saxonica, Grammatophora Subtillissima, P. Angulatum, P. Attenuatum, P. Macrum,* &c., nor on Nobert's plate, as Merz's objective. Hartnack asks the question, "Are large apertures an advantage to the microscopist or to the optician?" and he frankly says that "the disadvantages are for the latter only."

The advantages mainly claimed for the Immersion objectives are:—greater working distance between the object and objective, increase of light and superior definition and clearness in the optical image, which image is obtained by much simpler illuminating apparatus and with less manipulative skill than that considered indispensable in using high-power dry objectives.

It is not difficult to see that Amici's system, of connecting the objective with the cover-glass by a film of water, very much diminishes the reflexion which necessarily takes place on the incidence of oblique light when the dry objective is employed. The limiting angle of refraction in water being about 48 degrees, it follows that, whatever is the degree of obliquity in the incident light on the object, the Immersion objective never has to do with rays of greater obliquity than 48 degrees. To this, in great measure, is due the greater clearness and precision of image obtained.

Continental opticians and men of science have been aware of the merits of the Immersion system during several years past; and to such purpose, that knowing how little attention it has received here, they do not scruple to say that the English no longer take the lead either as opticians or as microscopists.

There are amateurs who make a speciality of declaring that all Test-objects can be resolved by some wonderful $\frac{1}{4}$th objective. I am told, for instance, that coarse transverse and very fine straight longitudinal lines can easily be seen with a $\frac{1}{4}$th on *Surirella gemma*. It is well known that a low-power will show transverse lines; but no objective or method that I know of shows straight longitudinal lines on this diatom. The finest images that I have seen of *Surirella gemma* (with Hartnack's $\frac{1}{18}$th and Nobert's $\frac{1}{20}$th), do not confirm Hartnack's opinion that the surface is a series of elongated hexagons, similar to the drawing in his pamphlet on "Test-objects" (published in 1865, and copied by Dr. Carpenter in the last edition of his work on "The Microscope"), but show it to be analogous to that of the *Grammatophora subtilissima*. *Surirella gemma* may truly be called a *touchstone* for a high-power objective. I do not think that it has been clearly defined as yet.

Those who profess that so much can be done with $\frac{1}{4}$th objectives in resolving Test-objects must not expect higher powers to verify the results they obtain. The whole art of testing objectives, I imagine, is in being sufficiently critical as to what is a fine image. The image shown of Test-objects by a high power of fine definition is so much more elaborated as at once to prove that the lower powers do not give true definition beyond a moderate magnification. For example, a good $\frac{1}{4}$th by Dallmeyer shows transverse lines on the *Grammatophora subtilisima;* whereas, with equal magnification, but with power in the objective (as in Hartnack's $\frac{1}{16}$th) rather than in the eye-piece, these transverse lines are seen to be the result of

imperfect definition, and the surface appears similar to the *Grammatophora marina*, or *P. angulatum;* it is, however, much more difficult to resolve.

It has been said that objectives which give the best results on Nobert's Test-lines and on Test-diatoms necessarily give inferior images of Podura scale. It is quite certain that the more powerful objectives—those giving greater magnification and definition—do not give so flattering an image of Podura scale as is given by a good $\frac{1}{8}$th. But the fault, if anywhere, is in the object, not in the objective. Podura scale is as fine a Test as any for a $\frac{1}{8}$th, but not for the higher powers.

In conclusion, I would suggest that the Society should improve the collection of Test-objects in its possession, and specially that we should have one of Nobert's new Test-plates; so that the Fellows may try their objectives on a Standard Test of this kind.

III.—*Notes on the Mounting and Tinting of Sections of Animal Tissues for Microscopical Examination.* By H. Charlton Bastian, M.D. Lond., F.R.S.

(*Read before the* Royal Microscopical Society, *January* 13*th*, 1869.)

Having made a somewhat extensive series of experiments with the view of ascertaining the best methods of mounting sections of hardened animal tissues for microscopical examination, I now communicate the results of my experience to the Society, together with some notes as to the tinting of such sections, in the hope that this information will prove useful to a certain section of working microscopists.

In the 'Journal of Anatomy and Physiology' for November, 1867, I published an account of some methods of mounting sections of brain and spinal cord, which I hoped might facilitate the investigations of those who were working at the anatomy or pathology of these organs. These methods were easy of application and required no special practice for their successful execution. Specimens could be mounted in either of these ways in less than one-third of the time that was required by the most practised person for the mounting of similar specimens by Lockhart Clarke's methods, whilst the results (including the preservation of the tissue, and the degree of distinctness produced) seemed to be equally good. Since this period I have pursued my experiments in respect of the different methods of mounting sections of hardened organs, with the view of finding out, on the one hand, methods which might in a measure supersede the use of glycerine for the preservation of sections of kidney, liver, &c., on account of their more permanent and complete power of preserving these; and, on the other, of ascertaining additional processes for the mounting of sections of brain and spinal cord, which, whilst capable of being executed with equal ease and rapidity, might surpass the others, either as regards completeness of permanent preservation or as regards the quality of effect produced upon sections of nerve-tissue. In all these directions the experiments have, I think, yielded results of some value; and I hope more especially that, with the aid of the methods which I introduce for the examination and preservation of sections of the brain and spinal cord, the study of these organs may be much facilitated. Certainly it will now require no more special skill to make and mount a section of brain or spinal cord than it does to manipulate in the same way with portions of liver, kidney, or any other organ of the body, and the whole art of performing the necessary processes may be acquired in an hour or less. I do not mean to say that the method of mounting sections of nerve-

tissue, introduced by Lockhart Clarke, and which has done such admirable service in its day, is by any means a complicated one; but still, to ensure good results it does require a certain amount of practice on the part of the operator, and even though we attain to the utmost degree of skill, the mounting by this method will occupy about three times as long a period as when one of my equivalent methods is employed.

I have not been satisfied with glycerine alone as a preservative medium, because, although yielding for a time such excellent results, the specimens so mounted will not retain their characteristic appearances indefinitely. After some time delicate specimens preserved in this way are apt to become more or less granular in some parts and too transparent in others. What we want is a method or methods which will preserve specimens for any number of years without change.

I will first speak of the methods which I have found the best for mounting specimens of liver, kidney, spleen, lung, &c.; then of those which I employ for the mounting of sections of brain or spinal cord; and lastly I will give some directions for the tinting of sections with chloride of gold and other metallic preparations.

The Mounting of Sections of Liver, Kidney, &c.—About ten months ago I cut specimens from the same portion of a kidney which had been hardened in chromic acid,* and mounted them, without previous tinting of any kind, in about thirty different ways, so that, by comparing these specimens carefully with one another, I have now been able to ascertain what are the best methods for preserving all the characteristics of the tissues, and what methods are to be avoided on account of their tendency to render the sections too transparent—thereby obliterating their finer details. I will first speak of the various methods for mounting sections in balsams or in gum-resins.

I have employed gum-dammara and Canada balsam in solvents of different kinds, having previously found that gum-mastic did not answer so well as either of the preceding. The solvents tried with each were chloroform, tetrachloride of carbon, ether, benzole, and the common commercial benzine, which is simply a less highly rectified product than the former. So far as the choice lies between gum-dammara and Canada balsam, it is not a very important

* As a general rule I use the chromic acid solution in the strength of one of the acid to three hundred of water. There is often an advantage, however, in placing the part to be hardened in a solution of bichromate of potash for the first week or ten days (ten grains of the salt to an ounce of water), the solution being renewed two or three times during this period. The solution of the bichromate has a much greater penetrative power than that of chromic acid.

Of late a saturated solution of Picric Acid has been recommended for hardening tissues by Ranvier (see an early number of the new 'Journal de Physiolog. et Patholog.'); but I cannot speak at all positively as to its advantages or disadvantages, since I have scarcely given it a fair trial as yet.

one, though on the whole the best results have been obtained with Canada balsam. But as regards the solvents, it is much more important which one we select, as some of the solutions will keep well and even bear slight exposure to the air without undergoing change, whilst others will not. Although they have yielded fairly good results therefore, so far as the preservation of the tissues was concerned, I have now dismissed from use the solutions of the above-named resins in tetrachloride of carbon, ether, and chloroform, because all these solutions are more or less liable to become cloudy and granular in the stock bottles (owing to a molecular precipitation of the resin) after they have been kept for a certain time. Benzole and benzine are, however, much more stable products, and seem to undergo no change from moderate exposure to air or light—they simply evaporate—and accordingly I have found that solutions of gum-dammara or of Canada balsam in these keep clear and good for any length of time. Seeing also that the anatomical details of tissues are preserved at least as well in these as in the other solutions named, I now employ them only. I have not found any appreciable difference of result with benzole and benzine respectively; but as the former is a definite chemical product, and the latter a variable commercial article, I should recommend the employment of pure benzole. It will be seen, therefore, that the solution to which on the whole I give the preference is one of *Canada balsam in benzole*, which should be prepared as follows:—Some Canada balsam must be carefully heated in a shallow pot for a certain time, so as to drive off as much as possible of the turpentine which it may contain, then it should be poured into a small bottle and sufficient benzole added for the solution of the balsam;* after all the balsam has been dissolved, the solution should be filtered through very thin filtering paper into a stoppered bottle, and so kept in store—what is required for immediate use being poured into one of Highley's drop-bottles.

Preparations may then be mounted in this solution in either of two ways:—

1*st Method*. The section cut from a hardened organ is allowed to remain in a watch-glass with some spirits of wine for two or three minutes, then a drop of carbolic acid† having been placed upon the glass slip on which the specimen is to be mounted, the section is taken from the watch-glass on the tip of a small scalpel, its dependent edge brought into contact for a moment with a piece of clean

* This should be done gradually so as to get nearly a saturated solution of balsam in benzole. If shaken a little from time to time, the solution will be complete in from thirty minutes to half-an-hour.

† When procured from the chemist this is in the form of acicular crystals; but the addition of a very few drops of water is sufficient to permanently liquefy three or four ounces of the acid.

blotting-paper, and then gently laid on the surface of the carbolic acid. This renders a thin section perfectly transparent in about half-a-minute. The superfluous carbolic acid should then be got rid of by tilting the slide and applying a small piece of blotting-paper to the edge of the specimen; this done, two or three drops of chloroform should be poured over the section and allowed to remain in contact with it about one minute, and during this time the specimen may be properly arranged in the centre of the slide. A slight tilting of the slide then suffices to get rid of the chloroform, when, before the specimen becomes dry, two or three drops of the solution of Canada balsam in benzole should be poured over it from the drop-bottle, and the covering-glass then applied. The mounting is thus finished, and the specimen only requires a certain amount of protection for a time till the balsam in which it is mounted has become hardened.

2nd Method.—The section having been placed in the watch-glass with ordinary spirits of wine for about a minute (merely to wash it), is then removed to another watch-glass, or small covered capsule, containing absolute alcohol, and allowed to remain in this for five minutes. It is then to be removed and placed on the slide on which it is to be mounted. The superfluous alcohol having been got rid of, it is covered with one or two drops of benzole for about a minute (which renders the section as transparent as if it had been placed in carbolic acid), and then, this having been tilted off, the additional steps are as before, *viz.* Canada balsam in benzole from the drop-bottle, followed by the application of the covering glass.

These methods yield about equally good results, but the first method, which I think most would prefer, does not always answer for sections of liver, and therefore we are obliged to adopt the second when dealing with this organ. The sections of liver generally shrivel, and become gelatinous when placed in carbolic acid, though I have not found the same thing occur with any other tissue.

Even untinted specimens undergo little change when mounted in this way, but still they keep so satisfactorily after tinting, that I am disposed to recommend these methods, principally for the preservation of specimens that have been previously tinted, reserving a different treatment for the untinted specimens.

I have also tried the ordinary spirit-varnish of commerce, as a medium for mounting and preserving microscopic specimens. Although having the colour of dark-brown sherry when seen in mass, the thin stratum of this solution between the two glasses comes to be practically colourless. The process for mounting in this medium is exceedingly simple—the section only requires to be soaked in spirits of wine for about five minutes, so as to abstract all water; then it should be placed on the centre of the glass slide, a few drops of the spirit-varnish poured over it, and the covering

glass applied. After a time the varnish hardens in the same way that the solution of balsam does. But the great objection to this most facile method is, that in the course of a few weeks untinted specimens, mounted in this manner, become so very transparent that more than half their details are obliterated. If specimens be very deeply tinted, however, this method answers fairly well. I have found that specimens of liver mounted in this way are preserved almost better than any other organ, though it does not answer at all well for sections of tubercle, since it renders the fibrous element here, as elsewhere, too uniformly transparent. This method might, however, prove very useful, occasionally, for the mounting of thick opaque sections, which require a good deal of clearing up, and also to some persons, perhaps, engaged in other kinds of investigation, who might be glad of a balsamic medium of this kind, possessing even greater powers of rendering objects transparent than Canada balsam itself.

The methods hitherto mentioned are what I advise principally for the preservation of specimens which have been previously tinted and are principally applicable also for sections of organs. But many specimens, whether sections or mere fragmentary portions of tissue, we may not desire to tint, and these are, I think, best preserved in a mixture of glycerine and carbolic acid, in the proportion of fifteen of the former to one of the latter. In the paper before alluded to, I recommended a mixture of these two ingredients with the view of correcting the tendency that glycerine alone has to render specimens too transparent or too granular after a time. But I now use much less of the carbolic acid than I then recommended, so that now also it is not so necessary that the specimens should be immersed in spirits of wine first; they may be taken at once from water, and transferred to the glycerine and carbolic acid in which they are to be mounted, provided only that the excess of water be first removed by bringing a portion of the specimen for a moment in contact with blotting-paper. The natural appearance of thin sections is beautifully preserved in this way, only the sections must be thin, since preparations so mounted are not nearly so transparent as when in glycerine alone.

Another method, which I have oftentimes adopted with great success, for the preservation of very delicate tissues, without the least loss of detail, is one for a knowledge of which I am indebted to Mr. Lockhart Clarke, at whose instigation I first tried it. This consists in mounting the specimen in a very weak aqueous solution of bichromate of potash—about one of the bichromate to 1000 parts of water. In using an aqueous medium, such as this, however, we are placed, as it were, at the mercy of the cement we employ. If this be not good, we may at the time when we most regret it, find a valuable specimen ruined, owing to some crack or imperfection in

the border of cement having permitted the water to evaporate. Incomparably the best cement I have met with is one which is much used in Germany, consisting of a solution of gum-mastic in chloroform, thickened with nitrate of bismuth.* This may be easily kept at the proper degree of consistence by the addition of a few drops of chloroform from time to time. I use it also for the specimens mounted in glycerine and carbolic acid. It does not run in, it hardens quickly, and when thoroughly dry has a stone-like consistence and is not liable to crack.

The Mounting of Sections of Brain and Spinal Cord.—There is now no longer any particular art or practice required to enable persons to mount and preserve successfully sections of brain and spinal cord. The best methods for ordinary use that I know are the two already described, as applicable for sections of other organs. These are suitable both for anatomical and for pathological investigations, and specimens so prepared, without tinting, preserve their characters with less change than when prepared by any other method that I have tried. It is, however, I think, more desirable to tint specimens of nerve-tissue that we may wish to preserve than when we are dealing with sections of other organs, since these derive a more than proportional advantage from the process.†

The simple process with spirit-varnish is also applicable for the preservation of sections of nerve-tissue, but it is not nearly so useful as the others. When first mounted in this way, the sections have almost precisely the same appearance and transparency as they would have if immersed in glycerine; but, very slowly, they become more transparent, and at last, after about six weeks, they get into a stationary condition, which accords, as nearly as possible, with the state of specimens mounted by either of the other two methods. Thin sections preserved in this way should always be tinted pretty deeply.

The solution of glycerine and carbolic acid is also a medium which may be often used with great success for the preservation of very delicate sections of nerve-tissue. I have found this method of great assistance when investigating the anatomy of the brain and spinal cord, in some of the lower vertebrata.

But I now come to the description of a method which is entirely new as regards the results which it is capable of producing—applicable for anatomical rather than pathological investigations—the bringing of which, to its present state, has cost me much time and labour. The method is only a modification of one of the

* The solution of mastic in chloroform should be nearly a saturated one, and a considerable quantity of bismuth must be added—the cement should be of a dead-white colour. It may be obtained from Mr. Ladd, of Beak Street.

† I may state also that Mr. Matthews, of Portugal Street, has lately made for me a very excellent Valentin's knife, of a much larger size than those ordinarily employed, with which most excellent sections of hardened organs may be made.

others, and as I now work it, preparations can be prepared just as quickly in this way as by any of the others. I first got a hint as to the possibility of preparing nerve-tissue in this way about eighteen months ago, owing to a quite accidental effect produced whilst making some experiments at that time. But for a long time the production of this effect was so much a matter of chance, that I said nothing on the subject in the paper in the 'Journal of Anatomy and Physiology,' and it is since that time more especially that I have striven to perfect it so as to make it yield more constant and uniform results. In this I have succeeded to a certain extent. No advantage whatever is derived from tinting when this method is employed, since the characteristic effect of the method is that it throws the nerve-cells and their ramifications into great prominence, whilst at the same time it subordinates the intermediate granular-looking material, and enables us to resolve this into its ultimate elements.

At first I obtained this effect by saturating the section in strong spirits of wine for a time, then suspending the section from the tip of a scalpel (after having removed superfluous spirit with blotting-paper) till it became quite dry and began to shrink. The section was then placed in a drop or two of chloroform on the glass slide, which caused it immediately to regain its form and become more or less transparent. During this time it was examined under a low power of the microscope, and when the characteristic effect was brought out, the superfluous chloroform was tilted off, some solution of Canada balsam in chloroform poured over it, and the covering-glass was then applied. When I first began to operate in this way the weather chanced to be dry, with very little moisture in the air, and the results were fairly good; but when, after an interval of a month or so, I again began to prepare sections by this method, every attempt was a failure, and it was not till I had spent many days in all kinds of trials with fresh spirit, fresh chloroform, &c., that I became convinced that my failures were due to the humid state of the atmosphere. It was in mid-winter, and there had been a constant succession of wet days. It seemed that the section, during the process of drying, had imbibed a certain amount of moisture from the air, and it was the presence of this that made the sections, after the application of chloroform, perfectly dark and opaque, instead of more or less transparent. Then I felt that it would not do to rely upon the drying process in a climate such as ours, and I sought to bring about the same result in other ways.* After innumerable experiments with different

* So far as I can understand the effects produced by this method, I am inclined to think that they depend upon the presence of a *very minute* quantity of water still remaining in the section, and principally in the nerve-fibres, the nerve-cells, and their ramifications. These probably would be the last portions of the

agents I found that the same results could be brought about quite independently of atmospheric conditions, by immersing the section for about ten minutes in absolute alcohol diluted with eight per cent. of water, then placing it upon the glass slide, and before it became dry pouring over it two or three drops of acetone,* in which it was allowed to remain from $\frac{1}{2}''$—$1''$, then tilting this off, and replacing by chloroform. The effects were then watched, as before, under the microscope, and, at the suitable time, the solution of Canada balsam was added and the covering-glass applied. There were two great disadvantages in connection with specimens prepared in both these ways; one was that the section itself was more or less obscured by minute granules of balsam, which had been precipitated out of its solution in a molecular condition by contact with the specimen; and the other, that sections so prepared did not retain their characteristic appearances more than about six weeks or two months,—after that time they began to grow uniformly transparent, and were no longer of any use. The first disadvantage I have succeeded in obviating by using the solution of Canada balsam in benzole, instead of the balsam in chloroform, which fortunately gives a preparation similar in all other respects, but free from the defacing granules of molecularly precipitated balsam. The last disadvantage, however, in spite of all my attempts, still remains, the specimens so prepared have only a temporary value and will fade after from six weeks to two months. If absolute alcohol cannot be procured so as to enable the dilution I have mentioned to be made, then strong spirits of wine may be used instead, and the specimen requires to remain in the acetone for from $1''$—$2''$ instead of for the shorter time before specified. I have also succeeded in making good preparations with ordinary spirits of wine, by immersing the section taken from this in acetone for about half-a-minute, then washing with benzole for the same time, before pouring on the chloroform and subsequently adding the solution of Canada balsam in benzole. The specimens when immersed in chloroform and found by microscopic examination to be fit for mounting, always present a slightly cloudy or opaque appearance to the naked eye, and this is generally notably increased on the addition of the solution of balsam in benzole. But the operator must acquire a certain amount of experience for himself before he will be able to use this method with success, and unless his reagents be all perfectly pure and fresh he will almost surely fail to secure satisfactory results.

tissue that would give up their water. But the quantity remaining must be neither too much nor too little—if too much, the specimen becomes more or less opaque generally; and if too little, as after immersion in absolute alcohol instead of spirits of wine, it becomes, when prepared in the same way, uniformly transparent. A section properly prepared should present a whitish cloudy opacity to the naked eye.

* Pyroacetic spirit.

The whole section can rarely or ever be prepared in a perfectly uniform manner, certain parts of it may be most admirable, whilst others may be either too transparent or too opaque. Whilst this mars the beauty of the preparation, it presents certain advantages occasionally, and may assist us to work out the histological details of a tissue. By the aid of this method, I have been able to make some important observations upon the minute anatomy of the cerebellum more especially, which will, I hope, soon be published.

On Tinting with Chloride of Gold and other Metallic Preparations.—Many people seem to experience some difficulty in the use of chloride of gold as a tinting agent, on account of the uncertainty of its action and the irregularity with which it stains the tissue. Dr. Beale speaks somewhat slightingly of it on that account, and I at first experienced the same difficulties when attempting to use it in the manner recommended by Gerlach. I found that sometimes the gold did not stain the tissues at all, but was reduced for the most part in a molecular condition in and upon them, whilst at other times the tissue was tinted, but in a most unequal and irregular manner. I have for some time past, however, succeeded in overcoming all these difficulties by the use of a different reducing agent, and can now recommend the following method as one which will yield constant and satisfactory results; the colour obtained being generally a rich purple, which undergoes no change whatever. The sections or portions of tissue are to be placed in a solution of chloride of gold (about 1:2000) made with water acidulated by hydrochloric acid in the proportion of one drop of the strong acid to two-and-a-half ounces. The sections are allowed to remain in this solution, protected from the light for one hour, are then removed, and moved about for a few seconds in acidulated water only half as strong as that mentioned above, and then transferred to a watch-glass or small capsule containing equal parts of formic acid* and of spirits of wine. This acts as a reducing agent and does not seem to injure the tissue in the least. The length of time required for reduction varies altogether with the temperature of the solution; if this be made lukewarm by placing the capsule near a fire, the reduction and staining of the tissue may be complete in about half-an-hour, whilst if the solution be kept cold, the same amount of reduction may not be brought about in less than three or four hours. The solution must never be placed too near the fire, however, since the formic acid and spirit, when hot, will damage the specimen as much as if it had been placed in pretty strong acetic acid.

If it be desired to tint very *rapidly* as well as permanently,

* I tried many reducing agents, but found formic acid by far the best. What I have employed has been analyzed and found to contain about nine or ten per cent. of the pure acid (CH_2O_2).

these results may be attained by making use of a solution of bichloride of palladium, which gives to the tissue a rich brownish-black colour. This should be used in the strength of one part of palladium to five hundred of water, and the specimen need only remain in this solution for ten minutes; it may then be removed, washed in the same way with acidulated water, and transferred to the capsule containing the formic acid and spirit. In a warm place, the reduction of the palladium and staining of the tissue is complete in about a quarter of an hour. Both these methods are applicable for sections of brain and spinal cord, or of any other organ.

There is a method of double tinting also, with silver and gold, which I occasionally employ, and which yields beautiful results with sections of the kidney. The section, if taken from an organ hardened in chromic acid, requires to be first soaked for a time in water, in order to get rid of all this acid—and this is more rapidly brought about if the water be somewhat warm. Then it is placed in a solution of nitrate of silver (1:600) for five or ten minutes; taken from this, washed in pure water for a minute, and thence transferred to the acidulated gold solution as before. After the reduction of the gold by formic acid, the specimen may be mounted in the solution of Canada balsam in benzole, and then exposed to light, in order to bring about the complete reduction of the silver. When this has been done, it will be found on microscopical examination, that the epithelial elements are for the most part stained of a brownish-black colour by the reduced silver, whilst the intervening fibrous tissue elements and the walls of the vessels are stained purple by the reduced gold. The two kinds of tissue elements seem to exercise a sort of elective affinity for the different metals.

I bring these forward as additional methods of tinting, rather than because they possess any decided advantages over the more ordinarily employed carmine process.

IV.—*On some undescribed Testaceous Rhizopods from the North Atlantic Deposits.* By G. C. WALLICH, M.D., F.L.S.

AMONGST the deposits of which specimens have been obtained by the sounding machine, from great depths, in certain parts of the North Atlantic, I have occasionally met with some elegantly shaped minute siliceous-shelled organisms, the characters of which are sufficiently distinct to indicate that they do not belong to any of the commonly known and most largely distributed types of the Oceanic Rhizopods. Owing to their comparative scarcity, and the difficulty of separating them from the mass of the material in which they occur, I am unable to state if any specimens reached the surface in a living condition. But, so far as I am aware, there is not any less indirect evidence for assuming that they live at the depths from which they have been obtained than that derivable from the circumstance of their not having been heretofore detected, at the surface, in those portions of the open ocean which have long since been carefully investigated by naturalists. Moreover, judging from certain peculiarities in the configuration of one of the varieties about to be noticed, it would rather seem probable that their natural abiding-place is at, or near, the surface; and that, in common with the free-floating pelagic Diatoms and Protozoans

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EXPLANATION OF PLATE III.

FIG. 1.—Shell of *Cadium marinum*, after Bailey.
" 2 & 3.—Test and Animal of *Lagynis*, after Schultze.
" 4.—Test of *Euglypha alveolata*, Bengal variety.
" 5.—Shell of *Cadium marinum*, from the North Atlantic, with recurved neck.
" 6.—Shell of *Cadium marinum*, with straight neck.
" 7.—Shell of *Cadium caudatum* (nov. spec.), showing septum and communication between the body and neck, very analogous to that shown by me to be present in the fresh-water *Difflugia septifera*.
" 8.—Shell of the same without septum, meridional grooves or striation.
" 9.—Shell of the same, with the caudiform appendage and sarcode body rolled up into a spherical mass.
" 10.—Variety of the same, with expanded aperture.
" 11.—Small variety of *C. marinum*, with straight neck.
" 12.—Small variety of *C. caudatum*.
"*13.—More highly magnified view of anterior aperture of *C. marinum*.
"*14.—Highly magnified aperture found in the posterior position of some specimens of *C. marinum*.
" 15.—*Protocystis aurita* (nov. gen.).
" 16.—The same, without the ear-like processes.
"*17.—Highly enlarged fragment of shell of *P. aurita*, showing formation of ear-like processes—anterior aperture and shell structure.
" 18.—*Protocystis lageniformis* (nov. var.).
" 19.—*Protocystis spinifera* (nov. sp.).

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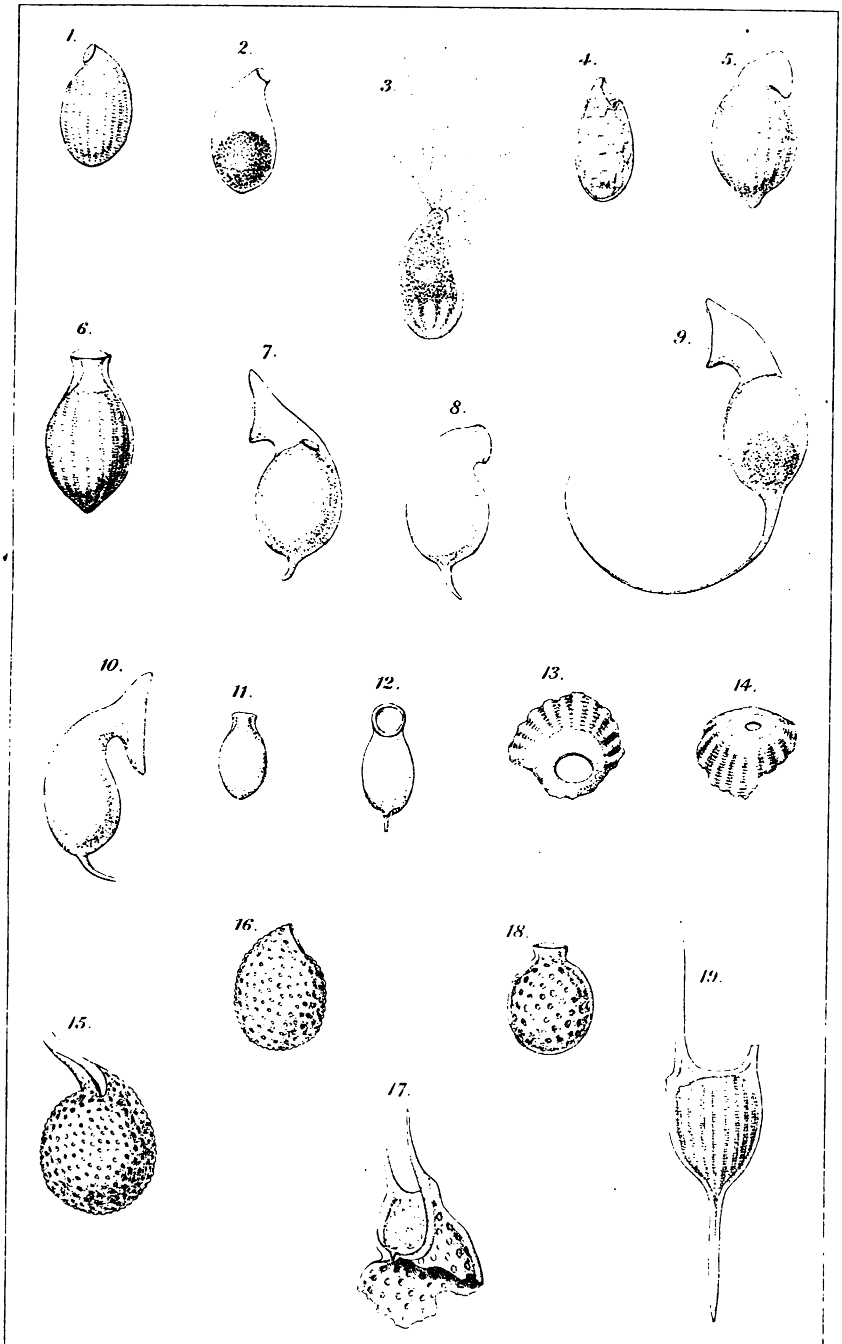
* Figs. 13, 14, and 17, prove from the lines of fracture that the appearance of striæ and depressions is not due to apertures in the substance of the shell.



G. C. Wallich del. Tuffen West sc.

Testaceous Rhizopods. (North Atlantic.)

whose hard parts subside after death to the bottom, their shells have, in like manner, made their way ultimately to the bottom. For, although specimens were now and then found in which the sarcode body was still visible, apparently in a fresh condition, as I have elsewhere repeatedly endeavoured to maintain, there cannot be a more fallacious test of the vitality, or even of the recent vitality, of these simply organized structures, than that which has been accepted by Ehrenberg and those who have endorsed his doctrines, as demonstrating it,—namely, the mere presence of the sarcode body within the shell of a Rhizopod, or of the Endochrome within the frustule of the Diatom. Indeed, it cannot be too strongly impressed upon those who are engaged in the examination of deep-sea deposits that, inasmuch as putrescence cannot in all probability occur under the conditions which prevail at great depths in the ocean, and the disintegration of tissues when it takes place (as it certainly does in some cases) is of the kind which results from new chemical combinations being brought about and not from simple decay, no mere collateral evidence of vitality should be regarded as conclusive in the absence of vital movements of the sarcode, such as the pseudo-cyclosis of minute granules within its substance or the projection of pseudopodial processes.

I may take the opportunity of mentioning a most singular fact, and one to which there has not, hitherto, in my experience been a single exception, that, although the effete shells of all the other known forms of oceanic Protophytes and Protozoans which are found living at the surface of the open ocean occasionally in vast numbers—namely, of the Diatomaceæ, Foraminifera, Polycystina, Dictyochidæ, Collosphæridæ, and one or two less known families—are to be met with in the deep-sea deposits, the beautiful spines (*Acanthostypes*) of the Acanthometræ are invariably absent. This is the more remarkable, since the Acanthometræ occur very abundantly in some latitudes, and are so unique in their characters that it seems scarcely possible that, if present in the deposits, they should so long have escaped detection. But this is not their sole peculiarity, for they are absent, in like manner, from the post-tertiary fossil earths of Barbadoes and Virginia, in which the remains of the Polycystina constitute so important a feature; and, so far as I know, they are likewise unrepresented in the chalk and flints. But, in the latter case, their absence is shared in a great measure by the Polycystina; these organisms occurring in the chalk and marls so rarely and, when they do occur, in such an imperfect state of preservation as to render their true nature somewhat doubtful.

In some of the deposits, now taking place in the Atlantic and also in eastern seas, which are said to represent cretaceous strata in the course of formation, the shells of the Polycystina are sufficiently

abundant to constitute a considerable percentage. Diatomaceæ and Dictyochidæ, moreover, which have indubitably lived at the surface and sunk down to the bottom only after death, occur unmetamorphosed in these deposits; and in no instance that has fallen under my observation, has there been any evidence tending to denote even partial disintegration of their shells and skeletons, either by gradual mechanical, or chemical, action taking place at the bottom of the sea. That no such disintegration does take place in the case of the Polycystina, even during the lapse of long geological periods, the fossil earths already referred to bear witness. The inference from these facts is obvious and highly important in its bearing upon the view which has been recently propounded as to the present being, in reality, a continuation of the cretaceous epoch. For it is clear that the absence of Polycystina from the chalk must either be satisfactorily accounted for (as they must originally have been present in it whilst it was being deposited, if the conditions of the sea-bed were the same then as now) or, to this extent at least, the present deposits cannot be regarded as analogous to those with which it is customary to compare them.

In the case of the Acanthometræ there is, however, an important difference. The action on these organisms of strong boiling nitric or nitro-hydrochloric acids shows them to be imperfectly siliceous. But no amount of subjection to boiling acids produces the slightest effect upon the shells of the Polycystina, Dictyochidæ, or the minute shells of *Cadium* and *Protocystis* about to be described in this paper. It is, therefore, both possible and probable that the sub-siliceous nature of the acanthostypes of the Acanthometræ causes them to be so rapidly acted on, after death, by the alkaline constituents of the sea-water, that they are disintegrated before they reach the bottom. At all events there seems to me to be no other mode of accounting for their *entire* absence from the deposits, notwithstanding that they occur abundantly at the surface of the ocean, although not always in the same latitudes.*

Accordingly, whilst the absence of the Acanthometræ from the post-tertiary fossil earths is only in accordance with their absence from the deposits now in the course of formation at the bottom of certain seas, it does not—as in the case of the Polycystina still found living at the surface of the ocean, and, I believe, only found

* I allude here to the transporting agency of the Gulf Stream, by means of which the frustules of many free-floating surface Diatoms, such as *Asterolampra* and *Hemidiscus*, and the like (which are strictly inhabitants of tropical and sub-tropical seas), are gradually transferred to the North Atlantic, probably die under the change of climate thus entailed on them, and then subside to the bottom as component parts of the deposits there forming. It is true the examples are rare, but they nevertheless suffice to show that the Acanthometræ, which are not confined to the surface-waters of tropical and sub-tropical seas, but occur in our own latitudes, may be in like manner transported.

dead in the deposits—interpose an awkward difficulty in the way of those who argue that the present geological period is, in every respect, a continuation of the cretaceous period of the past.

The only organism possessing a siliceous shell analogous to the first genus of those I am about to describe, of which I can find any published record, is one which was discovered by the late Professor Bailey, of New York, and described by him in 'The American Journal of Science and Art' for July, 1856, in a paper "On Microscopic Forms found in the Soundings of the Sea of Kamschatka." Under the head "Infusoria Rhizopoda," and amongst Diatomaceæ, Polycystina, and "Zoölitharia," Professor Bailey thus characterizes the form alluded to:—

"*Cadium:* nov. gen. Animal unknown (a Rhizopod ?); shell, siliceous ! ovoidal, with a bent beak and circular aperture." "*Cadium marinum:* shell with numerous meridian lines, of which about twelve are visible at once; length, 2^{m}; diameter, $1\frac{1}{4}^{m}$. I propose the genus Cadium to include some small shells whose siliceous structure I have fully proved, and which occur in the above-mentioned soundings as well as *in the Gulf Stream.* In the specimen figured, from 10 to 12 longitudinal striæ were seen at once on the upper surface of the shell; but in some specimens from the Gulf Stream the striæ were twice as numerous."

On comparing Fig. 5 of the Plate accompanying this paper with Fig. 1, which is copied from Professor Bailey's drawing of *Cadium marinum*, it will be seen that these two forms are generically and in all probability specifically identical, although differing from each other in some minor details, such as the size and degree of curvature of the "beak," the number of the meridional grooves, and the absence in Bailey's specimens of the minute tubercular process at the posterior part of the shell, which, in some of the North Atlantic forms, becomes developed into a remarkable caudiform appendage.

There exists, however, another Oceanic Rhizopod to which the Atlantic forms of *Cadium* seem to bear a very close resemblance; namely, *Lagynis.* This Rhizopod, which was first observed by Schultze in 1849 in the surface-waters of the Baltic, was described and figured in his work, '*Ueber den Organismus den Polythalamien,*' published at Leipzig in 1854. The shell of *Lagynis,* however, is described as being not siliceous, but chitinoid; and in this respect it differs from the shell of *Cadium.* Yet the general outline is so similar, and—what is of more importance—the general appearance and arrangement of the animal body, as seen whilst retained within the cavity of the shell, is of so peculiar and so similar a character in the two forms, that the question at once arises whether the presence in one shell of the siliceous ingredient, and its entire or partial absence in the other, may not, after all, be due to local conditions depending on habitat rather than to any inherent idiosyncrasy in

the structures. This question becomes the more readily admissible also from the circumstance that, so far as the careful observation of Schultze would tend to indicate, there does not appear to be a single important character, either as regards the chitinoid shell or the sarcode body within it, in which the marine *Lagynis* can be said to differ from certain varieties of the well-known fresh-water Euglyphidæ. And it is hardly necessary to point out that, instead of there being any *a priori* reason why the marine and fresh-water forms of Protozoa should not, during the lapse of vast geological periods, become capable of sustaining life under the opposite conditions inseparable from these two distinct habitats, examples are by no means wanting which go far to prove that the transition from a marine to a fresh-water habitat may actually take place within comparatively limited periods of time, and with results analogous to that which constitutes the distinguishing feature between the chitinoid shell of the *Lagynis* and the siliceous shell of *Cadium*.

According to Schultze, the sarcode body of *Lagynis* rarely fills the cavity of the shell, the posterior portion of the latter being occupied by four tapering prolongations, which, together with the sarcode mass from which they proceed, is composed of granular sarcode more opaque than the rest, whilst a clear globular portion is seen to occupy the centre of the mass. The pseudopodia are of a distinct Actinophryan type: the entire sarcode substance being at times rolled up into a spherical mass, which retains the clear portion at its centre and occupies the posterior part of the shell. (See Figs. 2 and 3, which are taken from Schultze's work.)

The second genus of new oceanic forms to which I am desirous of calling attention is even more scarce in the deposits than *Cadium;* and it has not been my good fortune to detect a single specimen in which the sarcode body was even partially visible. Although from the general appearance and characters of the siliceous shell it seems highly probable that they are closely related to *Cadium*, they exhibit one striking peculiarity which is sufficient to warrant their being provisionally placed in a separate genus. I allude to the possession of a process which, in one variety at least, appears capable of being detached from the main body of the shell, as if it were constituted of a distinct and separable portion. To this genus I have given the name of *Protocystis;* leaving the exact nature and affinities of the sarcode body both of this genus and of *Cadium* to be determined when an opportunity of examining their living tissues shall have been obtained. Meanwhile I can only express regret at its being out of my power to enter more fully in each case into the details of the animal structure.

Class. RHIZOPODA.
Order 3. *Proteina.*
Fam. 1. *Acti a.*

Gen. *Cadium.* Bailey. Shell, siliceous, hyaline, entire, oval, or lageniform.

C. marinum. var. α. (Wall.) Shell, lageniform, but with the neck recurved, so as to place the anterior aperture in a vertical plane; aperture, about $\frac{1}{3}$rd the diameter of the body of shell; length, about $\frac{1}{300}$th of an inch; meridional grooves about 5 in ·001 of an inch; striæ, 15 in ·001 of an inch. Plate III., Fig. 5.

Var. β. (Wall.) Shell, lageniform; neck, not bent; aperture, at a right angle to the long axis of shell; posterior extremity in both these varieties, with a minute tubercular or mammiliform elevation. Fig. 6.

The shell of *Cadium* differs essentially from that of the Foraminifera in being purely siliceous, which the shells of the *Foraminifera* never are; and from those of the *Polycystina* in being, although purely siliceous, entire and imperforate save at its anterior and posterior apertures. The anterior aperture is circular, frequently somewhat thickened. The meridional grooves are striated, the grooves never extending beyond the base of the neck of the flask-like shell.

Hab. North Atlantic, at depths varying from 371 to 2000 fathoms.

C. caudatum. N. S. (Wall.) Body of shell, oval, produced anteriorly into a lengthened neck, which is more or less recurved, so as to place the aperture in a nearly vertical position; posterior extremity, surmounted by a delicate hollow and gradually tapered caudiform process (sometimes twice as long as the body of the shell) forming curve, the direction of which is towards the anterior aperture; surface of shell, sometimes quite plain, sometimes marked as in *C. marinum;* length of oval body, from $\frac{1}{250}$th to $\frac{1}{550}$th of an inch. Fig. 9.

In this example the anterior aperture is slightly expanded, and sarcode mass is seen rolled up into a spherical mass, as if encysted.*

In Fig. 8, the anterior aperture is of the same diameter throughout.

In Fig. 10, it is greatly expanded, and forms a saucer-shaped cavity.

In both these specimens the caudiform appendage has apparently been broken off close to the body.

Figs. 11 and 12 represent smaller varieties of the simple lageniform type and that with the recurved neck—the latter showing the anterior aperture in a front view.

Gen. *Protocystis.* (Wall.) Shell, siliceous, entire, hyaline; sub. globular; surface of shell fitted with minute circular depressions.

* This condition may, however, be due, with equal probability, to the death of the animal, and its subjection to a vastly increased pressure on subsiding to the bottom.

P. aurita. Shell, nearly orbicular; anterior aperture surmounted by two acuminate processes which, as in the case of the neck of *Cadium*, are bent downwards from the erect position. These processes are perfectly plain, the line of union between them and the body of the shell being distinctly marked. Diameter, $\frac{1}{250}$th of an inch; length of ear-like processes, about $\frac{1}{417}$th of an inch. Fig. 15.

Hab. North Atlantic deposits, in 871 fathoms.

P. globularis. (var.) Fig. 18. This form resembles the last in the general outline and marking of the siliceous shell; but the anterior aperture is not everted. It may be only an imperfectly developed variety.

P. cuspidata. N. S. (Wall.) Only a single specimen of this curious shell was obtained by me. It is purely siliceous and hyaline; the body being oval, and surmounted at one extremity by two, and at the other by a single mucronate process; surface of the shell grooved longitudinally and transversely situated, as in *Cadium*. As the specimen was in balsam before it was detected, no opportunity was afforded of tracing out its characters more fully.

Hab. North Atlantic, at 2000 fathoms.

V.—*On the Construction of Object-glasses for the Microscope.* By F. H. Wenham.

In introducing this subject, I must state that my practice has been merely one of experimental inquiry relating only to the construction of the highest powers, and as the results have been admitted by numerous comparisons to be satisfactory, I venture to assume that the methods employed by a self-taught amateur may form some useful addition to our stock of knowledge, and be of service to others who are inclined to pursue this light and elegant department of mechanical manipulation.

The directions for working glass surfaces to a correct figure, may appear to some too practical and characteristic of the workshop; but it is only by a strict attention and study of such details that perfection can be ensured, and without their aid the deductions of the mathematician must fail in their proof. Though the early training of a mechanical profession has familiarized me with such pursuits, yet I must confess that I am ignorant of the methods adopted by our best makers for working their minute object-glasses; and therefore if some particulars may have the merit of originality, others are perhaps not in accordance with the most improved practice.

I have received numerous letters at various times from different microscopists requiring information on these subjects; and as the whole science of microscopy is quite a practical one, I have good reason for knowing that any information relating to this point will be welcome to many, and be some atonement to those who have applied for instructions, and to whom I now make my apology, on the plea that the very limited time that has been at my disposal for the last ten years would not permit me to recall particulars that I had ceased to practise, or to enter into long written explanations upon the conditions of failure or success submitted to my notice. I now purpose from time to time to publish the results of such experience as I have acquired.

The first attempt to construct an object-glass ($\frac{1}{4}$ in.) is recorded in the year 1850, on the then well-known form shown by the cut. The back lenses had an excess of negative aberration, or were over-corrected, to enable the adjustment for covering-glass to be performed by the separation of the front lens, which was

under-corrected for that purpose. But on attempting to improve the correction by a difference in the radius of the concave flint of the triple front, it was shown that a considerable alteration was here required to effect a material correction for colour. Taking a ray at the focal distance from the front surface, and tracing its refraction through the triple, at all points it appeared to enter the concave surface nearly as a radius from its centre. Consequently, under this condition, the effect of the dense flint was partly neutralized.

It then occurred to me to try a single lens for a front. With this combination no satisfactory result could be obtained with respect to achromatism.

Early in the year 1850, Mr. Lister was occupied with experiments for the purpose of improving the higher powers, and then introduced the *triple back*, which has since so eminently proved to be the grandest step towards their perfection, allowing perfect correction to be obtained with the most extreme apertures.

Having received early information of this improvement, I set to work and again tried the single front in combination with the triple back, and constructed an $\frac{1}{8}$th on this system which is considered excellent to this day. For several years I stood alone in my opinion of its advantages; but as numbers of our best object-glasses of the highest powers are now made with single fronts, I am in a better position for advocating this form, particularly as its success was found to depend upon a relative difference of focal lengths in the two back combinations not hitherto employed by others.

At first the single front with the back triple was not successful. Though colour was nearly corrected, there was a deficiency of aperture, and the combination was spherically under-corrected. On viewing another object under a thicker covering-glass, the definition was greatly improved. By placing other pieces of thin glass over the object, the front lens had to be drawn still closer to the others. This gave an increase of aperture and more perfect definition. A single front was then made, of the thickness which had been found to give the best result, ascertained from the measurements of the additional pieces of thin glass over the object, and the effect was all that could be desired. On finding that the correction for spherical aberration depended upon the *thickness of the front lens*, the path became easy.

The cut represents an $\frac{1}{8}$th of 130° of aperture constructed *on this system*, six times the size of the original. The curves

are not given as radii, but as the diameters of the circles in thousandths of an inch—for I thus note them down for the convenience of making and finding the steel gauges and to prevent division into two-thousandths, which would frequently occur in the corrections. The following are the curves:—Back triple,—Posterior of crown, ·312; three next surfaces, crown and concave flint, ·440; front flat, diameter of lens, ·173; density of flint, 3·630; ditto of crown, 2·437.

Curves or templates of middle:—Back, ·233; contact surfaces, ·233; front, $1\frac{1}{4}$ inch, or $\frac{5}{8}$th inch radius; diameter of lens, ·138; density of flint, 3·686; ditto of crown, 2·437.

Single front of crown, ·100 or $\frac{1}{10}$th template; diameter of lens, ·930; thickness, ·570, measured from the top; density, 2·437.

The focus, or magnifying power, of the two back combinations is very nearly equal, and each $4\frac{3}{4}$ times that of the single front; for I have found that if the middle is of shorter focus than the back, that it is difficult to obtain satisfactory correction. The lenses are fitted into their cells without shoulders, as their diameter is only just sufficient to admit the full pencil of rays, and their surfaces are utilized to the extreme edge, a desideratum that can always be secured by a proper mode of working

(*To be continued.*)

VI.—*On the Organs of Hearing in Mollusks.* By M. Lacaze-Duthiers.

It is well known that the auditory organ of mollusks is reduced fundamentally to a nervous vesicle filled with liquid, in which float and vibrate calcareous particles, and that this vesicle is analogous to portion of the membranous labyrinth of vertebrate animals, in which is contained the otolites. Authors assign various functions to this apparatus in the different groups of animals, and thus lead to some confusion of the physiological attributes of the various ganglia of the nervous centres. *A priori*, this proposition is difficult to admit. Nevertheless, the works of the most eminent anatomists, such as Claparède, Leydig, and Huxley, express no doubt upon the point, and indeed I myself have in more than one paper confirmed the common error, which is due to the great difficulty of making suitable preparations, and to the method of conducting observations.

It is necessary to bear in mind the fact that the central nervous system of Gastropods (that is of the animals we are now considering) is composed of three groups of ganglia, whose physiological attributes are evidently distinct. In relation to the digestive tube, one is dorsal, or posterior, and supplies nerves to the organs of sight, of touch, and to the lips—in a word, to the head and its appendages, parts all endowed with an exquisite sensibility. The two others, abdominal, or anterior, send nerve filaments, the most anterior and superior, to the foot or organ of locomotion; the most inferior, to all the other parts of the body. I leave the sympathetic nerve out of consideration. The question then arises, *With which of these nervous centres are the otolites connected?*

In some gastropods in the Eolidæ and the Heteropoda, the auditory vesicles are evidently connected with the dorsal ganglia, which, as far as can be determined, are associated with sensation. In the Heteropoda especially, the otolites are suspended from the brain (?) (*cerveau*) as if from a long delicate thread.

In all the other gastropods, the auditory vesicles are figured and described as being intimately united to the pedal, or locomotor ganglia. On this point all writers express a distinct affirmative. Herr Adolf Schmidt alone has described a canal which establishes a communication between the cavity of the organ and the external surface of the body; but this is a further error founded on an appearance, but not on a demonstrated fact.*

In studying the histology of the central nervous system of a very small gastropod, the Ancylus of our streams, I found sus-

* *Giebel* und Heintz's Zeitschrift für die Gesammtem Naturwissenschaft. 1856.

pended to the cerebral, or sub-œsophageal ganglion, a vesicle which it was difficult to make out distinctly. I was led by this observation, and by my repugnance to admitting that an organ of sense may derive its nerve indifferently from either a motor or sensory centre, to researches which led me to this conclusion. The acoustic nerve invariably takes its origin from the sub-œsophageal or cerebral ganglion. The auditory vesicle may, it is true, rest on the pedal ganglion; but it never takes its nerve from this centre.

In order to study the otolites, it has been customary to raise the pedal ganglia, and to compress them under the microscope. This mode of preparation displays the vesicle; but it is seldom sufficient to demonstrate its relations, and the acoustic nerve can only be shown by the most delicate and careful dissection and manipulation. Tinting with carmine is of great advantage in these cases.

In cases where the otolites are at a distance from the pedal ganglia, they are extremely difficult to find, since they are buried in the cellular tissue of the general cavity. This is so in Cyclostoma, Calyptrea, Lamellaria, Natica, and in certain species of Murex and Paludina. I have had recourse to a chemical reaction, which immensely assists and simplifies researches. By plunging the animal into a solution of oxalic acid, the lime of the otolites forms a very white and very insoluble oxalate, and the tissues become more transparent. By this means the position of the auditory vesicle is very distinctly seen.

In very small species, a system of compression by a series of blows on the covering-glass will display the otolithic granulations penetrating into the acoustic nerve. If in these cases oxalic acid be employed, a white line may be seen, which leads to the cerebral and not to the pedal ganglion.

My researches have been made on more than thirty species, and I have never failed to demonstrate the relation I have pointed out; and I therefore regret to have to be compelled to oppose the opinions of Messrs. Leydig, Claparède, and Huxley, which express so distinctly the connection of the otolite with the pedal ganglion. In a recent excursion along the sea-coast, I have had the satisfaction of finding all the new species discovered by me range themselves under the following law:*—The position of the organ of hearing may vary, but its connection with the central nervous system remains always constant in the Gastropods, Heteropods, and Cephalopods. The acoustic nerve always arises from the sub-œsophageal or cerebral ganglion, which has therefore all the sense-

* These are the genera in which it is constant:—Limax, Arion, Helix, Zonites, Clausilia, Succinea, Physa, Lymneus, Ancylus Neratina, Paludina, Testacella, Cyclostoma, Pileopsis, Calyptrea, Natica, Nassa, Trochus, Murex, Cassidaria, Purpura, Patella, Haliotis, Bullæa Aplysia, Lamellaria.

organs under its control, while in the pedal ganglion resides the locomotor faculty.

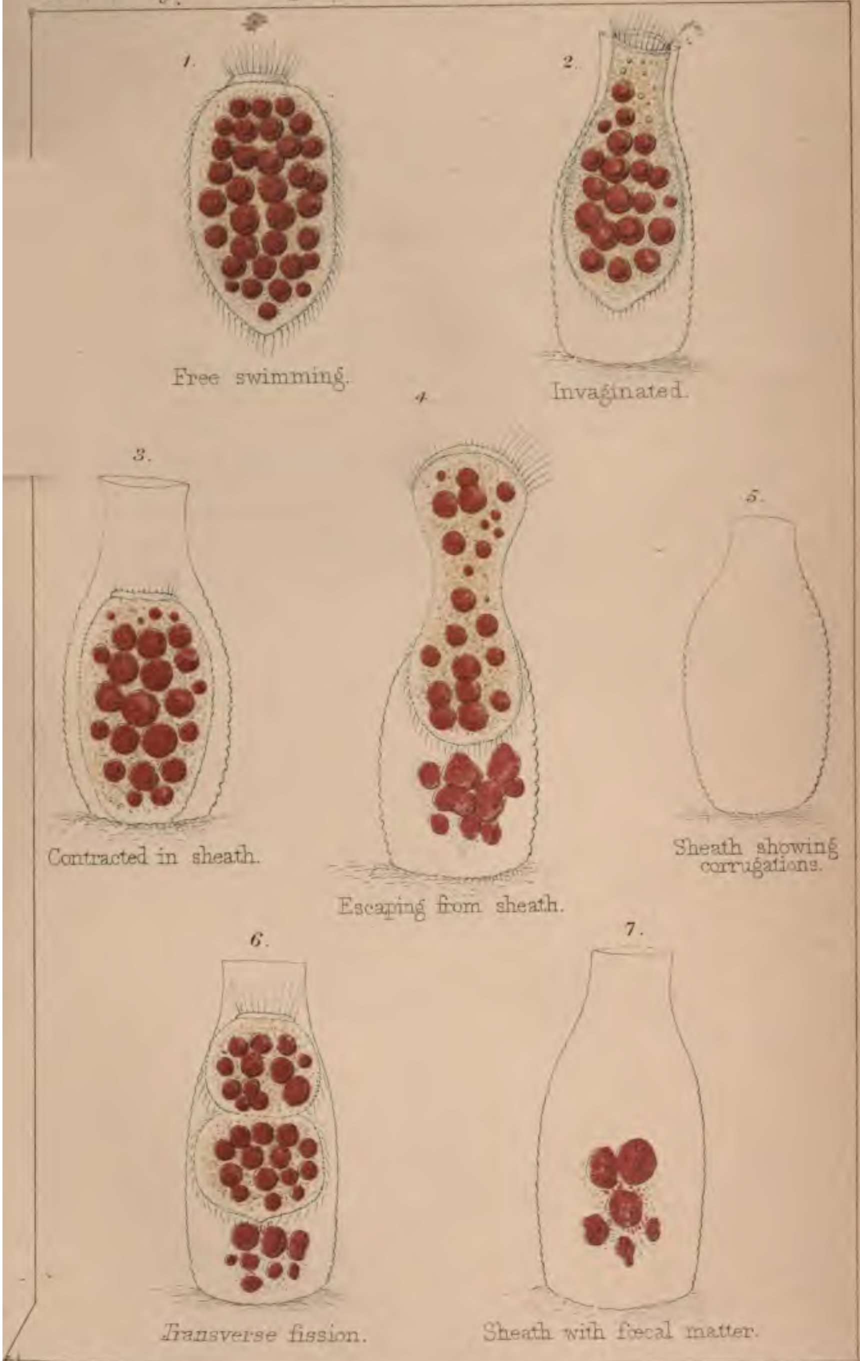
The fact of the variable positions and relations of the otolites had served as an argument against the "law of connections." My aim has been not to raise at this moment the grave question of the absolute fixity of those connections; but it is hard to avoid remarking how futile it is, in complex questions of zoological philosophy, to found general deductions on very minute details.

In assuming in Gastropods an organ of sense to be sometimes in connection with a motor and sometimes with a sensory ganglion, there resulted an exception to the "principle of connections"—of distinction between sensibility and motricity. But in reasoning thus, the same process was followed as that used for vertebrate animals before the discoveries of Bell and Majendie.

Certain connections have an invariable fixity. Morphological transformations alone can cause them to be misinterpreted. The study of the morphology of organs founded on the constancy of certain true relations should lead the malacologist to recognize "des parties destinées à lui fournir les caractères zoologiques destinés à la spécification."

In conclusion, it is demonstrated by my researches that the connection of certain parts of the nervous system of mollusks being fixed, sensibility and motricity are fixed in all the Cephalophora as in all vertebrates.

L'Institut, No. 1821.



Author, del. Tuffen West, sc. W. West, imp.

A new Infusorium. (Vasicola ciliata.)

VII.—*On a New Infusorium.* By J. G. Tatem.

From a receptacle for the discarded contents of collecting-bottles, which has been long exposed to the open air—a mixture therefore of rain-water and pond-water, from many localities, and now particularly offensive from decaying animal and vegetable matter—I have recently obtained an animalcule which has hitherto, I believe, escaped observation.

It occurs as both a free swimming and invaginated ciliated Infusorium. (See Plate IV.)

In the free swimming condition it is oblong, transparent, faintly plicate transversely, ciliated all over, the cilia fine, not arranged in longitudinal rows, longest at the terminal anal outlet, which is situate not quite in the axial line, but slightly lateral to it, and rather prominent. The oral aperture is seen in this stage as a raised margin or lip, edged with long cilia. The food-vesicles are numerous, crowded, and of a bright claret colour.

In the invaginated form, while at rest, it maintains precisely the same general outline and appearance. The investing sheath is firm, resisting, and perfectly hyaline, vase-shaped, with a somewhat patulous mouth, narrowing into a neck behind, then swelling into an ample, slightly corrugated body (the sides of which are, however, straighter in some examples than in others), with a truncated base, to which the contained animal is wholly unattached. Rising in its sheath when feeding, and elongating into a short neck as it presses forward, the mouth opens just below that of the sheath, as a circular orifice with a thickened margin, surrounded by a simple wreath of cilia, which creates an extended vortex around it. A short infundibulum conveys the food particles into the vesicle, which originates at its extremity, and in which the usual active rotary circulation is observed. It is noticeable that in this nascent food-vesicle colour is but faintly indicated. May not therefore the bright claret hue of the others be attributable to the chemical action of the assimilative process? It is certainly voracious,—vibriones, monadina, and minute particles of decaying vegetable matter are greedily absorbed.

Impatient of restraint, within a few minutes after being placed in the cage, in most instances it makes a hasty exit from its sheath, squeezing itself through the neck with difficulty, and leaving behind a considerable amount of fœcal matter, of the same bright colour as the food-vesicles, which in the cases of the larger masses is extruded through a positive rupture of the integument. It then swims off with the motion and general character of a Stentor, for a small species of which a careless observer might readily mistake it.

Transverse fission within the sheath has been repeatedly observed —both animals on its completion passing out in quick succession.

Length of extended animal, about $\frac{1}{180}$; of free animal, $\frac{1}{200}$; and of sheath, $\frac{1}{150}$ of an inch.

Two questions offer themselves for consideration. 1st, Is the animal normally a free swimmer, as the generally ciliated surface and its transverse fission would lead one to surmise—the invaginated condition being merely a temporary, seasonal, or winter one? And 2ndly, Is an alternation from the free to the fixed states, and *vice versâ*, of frequent occurrence in the life of the animal, determinable by the ever-varying conditions of temperature, light, and food supplies?

To one or other of these inquiries I shall hope at some future time to make a satisfactory reply, should I succeed in keeping these creatures under observation for a sufficient length of time.

Under the impression that the Infusorium now described and figured is generically new to science, I venture to propose for it the name of *Vasicola ciliata.*

NEW BOOKS, WITH SHORT NOTICES.

The Record of Zoological Literature. 1867. Volume IV. Edited by Albert C. L. G. Günther, M.A., M.D., F.R.S., &c. London: Van Voorst, 1868.—Dr. Günther's incomparable work, now in its fourth volume, needs no commendation at our hands to ensure its support among zoologists. It may be as well, however, to point out that the 'Record' is not exclusively devoted to zoology in a taxonomic sense, but includes reference also to the investigations of the year in which the microscopist is interested. It extends over nearly 700 pages of large 8vo, and includes the titles of the papers and books on zoological matters published in the year 1867. In addition, it gives brief analyses of all the more important additions to knowledge, and in all cases it mentions the source or journal in which the paper appeared. When we state further that it deals in this way with nearly *thirty-seven thousand* pages of zoological literature, our readers will see how essential, necessary, and indispensable the work is to all who are engaged in original research. This volume brings the record up to the end of 1867. The three preceding ones dispose of the work in the years 1866, '65, and '64, respectively. If the worker wishes to go back farther he must consult the appendix to the 'Natural History Review' (a now-defunct periodical), which contains a very valuable bibliography from about 1860 to 1863 inclusive. If he would go still farther back he must consult Carus' 'Bibliotheca.' It is quite impossible for any one engaged in biological inquiry to avoid ascertaining what has been done already in the field he proposes to cultivate, and this work of Dr. Günther's is intended to meet his wants in this direction.

We shall just give a brief sketch of some of the labours recorded by Dr. Günther and his colleagues, as this will convey a better notion of the work than any mere general statement as to its merits. Suppose for the sake of illustration we take the section devoted to Protozoa, and inquire what work was done in 1867 towards increasing our knowledge in this department. Here is a store of information collected by Dr. E. Perceval Wright. Let us glance only at the record of general treatises, leaving out the papers, &c., on species, as too numerous for our purpose. We learn that in that year there was one separate publication in this group, and that was Herr Stein's 'Der Organismus der Infusionsthiere," &c. "This is a folio with sixteen plates. It is the second part of Stein's great work on the Infusoria, and gives (1) a *résumé* of the result of the latest investigations into the structure, mode of increase, and development of the Infusoria, and (2) the Natural History of the Heterotrich Infusoria." Next, under the head of separate publications, *i.e.* papers which appeared in journals, proceedings of societies, and such like, we find an account of nearly thirty memoirs, all devoted to the general con-

K 2

sideration of the Protozoa, and quite exclusive of a multitude of papers on species and on the several classes of this sub-kingdom considered specially. We have not space to refer to all these general "separate publications," but we may mention a few of them. We find notices of numerous papers on Hyalonema. Apart, for instance, from the articles by our fellow-countrymen, we are furnished with references to memoirs by Signor Bocage, Ehrenberg, Max Schultze, and one on Euplectella by Herr Semper. Then there are recorded papers by Greef on *Actinophrys*, by Claparède on *Lychnophora*, by Cienowski on the structure of *Labyrinthulæ*, by Lieberkühn on the contractile structure of sponges, by Luders on the development of Bacteria and Vibriones, by Poulet on Infusoria in the air expelled from the lungs in hooping-cough, by Reichert on the contractile substance of Polythalamidæ, by Rouget on the muscular contractions of Vorticella, by Schneider on the structure of the Radiolariæ, and various other important contributions. We have said enough to show the great usefulness of the 'Zoological Record,' suffice it to state in conclusion that the work is now sold in three parts, any one of which may be had separately. One includes the vertebrates, the other insects, &c., and the third all the other invertebrates. Dr. Günther's confreres are Mr. Alfred Newton, Mr. W. S. Dallas, Dr. Edouard Von Martens, and Dr. E. Perceval Wright; and it is but scant justice to each and all to say that they have done their work thoroughly and satisfactorily.

On Molecular and Microscopic Science, by Mary Somerville, in two vols. London: John Murray, 1869.—With the "Molecular" or rather the "Physics" portion of the present work we have no immediate concern, but we may say a word or two about the other portion of Mrs. Somerville's handsome volumes. Imprimis—and it is a point which will surprise many of her readers—the author makes no more than an incidental allusion to the microscope. No form of instrument is described, and no instructions are given as to the collection, preparation, or mounting of microscopic objects. The work is essentially one on general Histology, animal and vegetable, with a sketch of some of the more interesting groups among the invertebrate animals, and is in great measure—if we are not much mistaken—based on Dr. Carpenter's admirable 'Microscope and its Revelations.' There is, of course, nothing that is new in a treatise which is admittedly a compilation, nor can we complain of this; but we have a right to expect that the compiler of a work like that before us has taken pains to collect accurate information, and to collate the matter collected from different sources so as to give uniformity of design, at least in semblance, to the whole. It strikes us that this idea, if it at all occurred to the author, has not been very rigidly adhered to. Further, we note that some of the most instructive animal groups—at least, in so far as "Microscopic Science" is concerned—have been very much neglected by Mrs. Somerville. This is, to a certain extent, evidenced in the section devoted to the Infusoria, and *especially* forcibly so in th e pages in which the

Rotifera, one of the microscopists' favourite groups, is summarily disposed of. This would be less remarkable were it not for the fact that so much greater an amount of space is allotted to creatures that hardly come within the limits assigned to them by the author. It is hard to say anything in praise of either of these chapters. The best part of Mrs. Somerville's volumes is, unquestionably, that which embraces descriptions of the Rhizopoda and Foraminifera. This is very fairly done, and it is exquisitely illustrated. The half-dozen or more large plates which represent, in white on a rich indigo background, species of *Haliomma*, *Actinomma*, *Aulocantha*, *Dictyopodium*, *Acanthometra*, *Eucyrtidium*, and *Rosalina*, are marvellous examples of artistic skill; they are unquestionably beautiful. The descriptions of the corals are taken, together with the figures, from Lacaze-Duthier's fine monograph, and are in keeping with recent research, but the chapters on Entozoa and Annelids are by no means satisfactory as representing modern science. The work has been seen through the "press" by several friends, but, unfortunately, it has been very carelessly "read," as printers say. It is full of orthographical errors.

Handbuch der Lehre von den Geweben des Menschen und der Thiere. Herausgegeben v. Dr. S. Stricker. 1 Lieferung mit 49 Holzschnit Leipzig. Engelman, 1868 ['Handbook of the Tissues of Man and Animals.' Edited by Dr. S. Stricker].—The first part of this work is just published, and contains some very interesting and valuable papers. There are the following contributions:—(1) On the Methods of Microscopic Study; (2) General Remarks on Cells, by Dr. Stricker; (3) On Connective Tissue, including Cartilages and Bone, by Herr A. Rollet; (4) On the Structural Elements of the Nervous System, by Herr Max Schultze; (5) On the Relation of Nerve to Muscular Fibre, by Herr Kühne, and other papers of interest. It is well illustrated, and the following are among its regular contributors:—Stricker, Arnold, Becker, Biesiadecki, E. Brücke, Cohnheim, Eberth Engelmann, Gerlach, Hering, W. Kühne, Langer, La Valette, Leber, Ludwig, W. Müller, Pflüger, von Recklingshausen, A. Rollet, F. E. Schulzte, Max Schultze, Schweigger-Seidel, and lastly, Waldeyer.

Parasitic Skin Diseases, by Dr. M'Call Anderson. London: Churchill, 1868.—We call the attention of our readers to this work because it deals with the interesting subject of the relation of fungi to disease, and with the problem of the mode of development of such fungi. Indeed, the greater portion of the book which Dr. Anderson has given us is devoted to descriptions of the structure, growth, mode of development, and relations of the various fungi which grow upon or in the integumentary system in cases of parasitic disease. The author has given a great number of very handsome illustrations, displaying these fungi in different stages of their growth, and as seen under powers of from 200 to 400 diameters. He refers also to the views expressed by Mr. Jabez Hogg in his paper, published a couple of years since in the 'Royal Microscopical Society's Transactions,' and he states that he differs from

Mr. Hogg, Dr. Fox, and Professor Hebra, in believing that the parasites of *Tinea favosa*, *T. trichophytina*, and *T. versicolor*, are all distinct species. Dr. Anderson records numerous experiments in support of his views.

The Journal of Anatomy and Physiology. No. III., Second Series. Macmillan & Co.—It is certainly rather "behind time" to notice a periodical published in November; but on the "better-late-than-never" principle, and from the fact that the journal is issued at half-yearly intervals, and contains some contributions of sterling value, we cannot afford to let it escape our readers' attention. Besides admirable papers on general anatomy, it has numerous notes of interest to the histologist, and there are two or three papers on microscopic structure which should be read by those engaged in studying the subject they relate to. One of these is "On the Changes in the Nervous System which follow the Amputation of Limbs," and is a most important and suggestive communication, by Dr. Dickinson, of St. George's Hospital. Another, by Mr. J. R. Lee, "On the Ciliary Muscle," is interesting; but is not pursued to its proper length. The microscopic relations of the muscle to the cornea, the choroid, and the sclerotic, have not been sufficiently explored.

Mémoires pour servir à la Connaissance des Crinoïdes vivants, par Michael Sars; avec 6 planches. Christiania: Brogger & Christie, 1868.—This is M. Sars' comprehensive memoir on the anatomy and general natural history of *Rhizocrinus lofotensis*, and is a work well worth the attention of those who are working at the Echinoderms. There is hardly any branch of the subject which has not been investigated by the author, and full details are given in the forty-six quarto pages of which the memoir consists. In order to make his remarks more intelligible, the author has appended a paper on the pentacrinoid of *Antedon Sarsii*, which was presented to the Congress of Scandinavian naturalists in 1856. Six admirable plates accompany this monograph, and delineate the structure of the two species to which M. Sars has particularly directed his attention. The author thus concludes the section on the affinities of *Rhizocrinus*:—"*Rhizocrinus* seems in some respects to be *a degraded type of the family Apiocrinidæ*, having most affinity with *Bourgueticrinus*, and, so to speak, a transition from the family Apiocrinidæ to the existing genus *Antedon*, and notably so in its larval state (Pentacrinoid). It is a dwarf genus (living at the bottom of the glacial sea of the North) of stalked Crinoids which were widely distributed in past epochs, but at the present time are represented by a few species which were hitherto believed to be confined to tropical seas."

Essai sur la Structure Microscopique du Rein, par Ch. F. Gross. Strasbourg: Treuttel et Wurtz, 1868.—M. Gross has here given us a very elaborate work on the structure of the kidney. We do [illegible] it to contain anything which has not been already brought [illegible] histologists. But its illustrative plates are [illegible] microscopic arrangement of parts, and

its histological sketch is very good. Those who wish to know how much of the anatomy of the kidney has been worked out, and how much remains for elucidation, should consult it.

Handbuch der Physiologischen Botanik, in verbindung mit A. de Bary, Th. Irmish, und I. Sachs. Herausgegeben von Wilh. Hofmeister, Erster Band. Zweite abtheilung mit 134 Holzschnitten. Leipzig: Engelman, 1868.—This part of Herr Hofmeister's fine work has been recently issued, and will well repay those who examine it. It gives us a number of illustrations with which English students are little familiar, and its chapters on the development of buds are of considerable importance. Indeed the part now issued deals almost exclusively with this subject.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Cholera Fungus.—The Reports of Drs. Lewis and Cunningham on the interviews with Professors Pettenkofer, De Bary, and Hallier, as recently published in 'The Lancet,' are of the highest interest not only to the student of Pathology but also to the Microscopist. It would be impossible within the space allotted to our "Record" to give even a summary of all the results, as indeed the epitomized form in which they are published in 'The Lancet' occupies some fourteen or fifteen columns; but as Professor Hallier's conclusions have already been controverted in Dr. Thudicum's paper in our last number, we think it is only fair to quote that portion of Dr. Cunningham's and Lewis' "Report" which relates to the interview with the Jena Professor. The experiments of Professor De Bary are also of some importance, and should be referred to by our readers. The reporters thus describe Professor Hallier's method of conducting his researches and the conclusions at which he arrives.

I. *Apparatus which Professor Hallier employs.*—These are generally rather complex, as Professor Hallier's method of observation depends for the value of its results on the supposition that isolation is as perfectly secured as possible.

1. The large apparatus, as described in his "Gährungs-Erscheinungen:"*—It consists of a glass flask, fitted with two tubes, one of which is connected with the isolating media, whilst the other enters the receiver of a small air-pump, by means of which any amount of air can be drawn through the whole apparatus. He thinks that, if it were possible (*i.e.* if a sufficient number were at hand), only this kind should be used. He considers its great advantages to lie: 1st. In its being as perfect an isolator as is possible to be obtained without resorting to great expense. 2nd. In its affording means for the supply of as much air as may be thought necessary. 3rd. In enabling the material cultivated to be used in considerable amount, which he con-

* P. 14.

siders almost essential for good results. Of course it has the disadvantage of not providing any means for the continuous observation of progressive development, as the results of the cultivation in it can only be examined on breaking open the flask.

2. The small apparatus: This consists of a small bell-glass, communicating with the air by a bent tube, and standing in a basin of permanganate of potash. In this, as described in the "Gährungs-Erschinungen," the substance to be cultivated is made to rest on a small glass or earthenware dish, so as to keep it out of the permanganate solution.

II. *The substrata which Professor Hallier employs.*

1. The freshly exposed pulp of lemon, "which, as freshly exposed, may be presumed to be free from spores or fungal elements."

2. Thick starch paste, containing some salt of ammonia.

3. Solution of grape sugar.

4. Cork which has been previously soaked in alcohol. This is carefully dried, and "when employed as a substratum is kept so, but surrounded by moist air."

5. Fresh potato.

In making a series of observations on development, he employs the large apparatus for getting fully developed results, and several of the small ones for results which may be frequently examined, and so show the steps of development.

In making any series of observations, two pieces of lemon, cork, &c., should be employed, on one of which spores are sown, and on the other they are not, so as to be able to compare the one piece with the other.

III. *A summary of Professor Hallier's view as gathered from explanatory statements made whilst demonstrating his preparations of cholera stools, &c.*—Professor Hallier stated that the fundamental idea of the whole theory is that "moulds are mere unripe forms of ustilagines." This is a view of his own, and is not generally recognized. He believes that any fungus of this series may appear under various forms; these forms depending on the nature of the substratum, and on the degree to which ripening goes on. If the spores of an ustilago be cultivated, two forms always appear—*viz.* the schizosporangic and the cladosporic forms; if the soil on which any of these forms appear alters or ferments, the forms produced are different. He states that each species of ustilago has three ripe forms of fructification, and that each of these has a corresponding unripe representative, the use of the unripe form being probably, according to Professor Hallier, to prepare a more nitrogenized soil on which the highest forms may be developed. "If *Tilletia caries* be cultivated on weak, poor soil, we get only unripe forms—*i.e.* moulds make their appearance."

These ripe and unripe forms may be thus tabulated, taking as an example the fungus associated with cholera :—

Unripe.	*Ripe.*
1. Macroconidia.	1. Tille[illegible]
2. Penicillium crustaceum.	2. C[illegible]
3. Mucor racemosus.	3. S[illegible] (cholera cyst).

The ripe forms are distinguished from the unripe ones by having a cuticula developed, which makes them much more resistant.

"Macroconidia" is the term which Professor Hallier applies to dilatations such as occur in mucor racemosus. He believes that they are unripe forms of fructification, and are capable by a ripening process of becoming *Tilletia caries* spores; but in place of ripening they may, unlike the ripe spores, germinate at once. If the soil on which this germination takes place be sour and poor in nitrogen, penicillous forms result, *i. e.* the unripe representative of the cladosporium. If, on the other hand, the soil be rich in nitrogen, mucor forms appear, *i. e.* the unripe representative of the schizosporangium. A schizosporangium is precisely the same as a mucor sporangium, save that it has a cuticula developed on its exterior, and that the contained spores are each provided with a sheath.

The mode of germination in the two forms is quite distinct. Each spore on a schizosporangium on germinating gives origin to a filament, which pierces both the sheath peculiar to the spore and the wall of the containing capsule, without rupture having taken place. In the mucor sporangium, on the contrary, rupture or disappearauce of the capsule always takes place before germination, as it, being destitute of a cuticula, is not strong enough to resist the pressure of the swelling spores. The only form of the series associated with cholera which is peculiar to the disease is the schizosporangium or the cholera cyst; but they may probably on investigation be found to occur on the rice plant in India. The schizosporangia of the cholera series are in this climate peculiar to the disease only. They can only be developed on a nitrogenous basis, and under a high temperature. Cholera originates under the same conditions in which true cysts can be produced. This may possibly cause the difference between Asiatic and European cholera—the first being due to the micrococci of the schizosporangia; and the second to the micrococci of their unripe representatives, mucor sporangia, as well as to the indigenous ripe form, tilletia spores.

Professor Hallier does not state positively that cholera is due to the fungus, and he does not believe that any infectious disease can be caused by spores *per se*. It is only micrococci that are efficient agents in producing disease. This may account for the fact that tilletia spores can be, and constantly are, swallowod in large quantities without producing any bad effects. They are not retained long enough in the intestinal canal to produce micrococcus, and therefore pass through quite passively.

The question of "micrococcus" being thus introduced, Professor Hallier stated his views on the subject. He defines micrococcus as "particles of plasma without any cell-wall." When these particles acquire such a wall they become either "cryptococcus" or "arthrococcus," according to the nature of the medium in which they are contained. Micrococcus, on being introduced into a fluid capable of alcoholic fermentation, becomes cryptococcus, corresponding with the bodies which are generally included under the vague term "yeast cells." If, on the other hand, micrococcus be introduced into a fluid

capable of sour fermentation, they become arthrococcus, *i. e.* they assume an elongated form, and become one form of what are commonly termed bacteria. The term "bacteria," as usually applied, includes both arthrococcus and micrococcus, but no idea of their nature and relations had been attained until Professor Hallier discovered that they were merely the ultimate elements of fungi.

Micrococcus and arthrococcus are multiplied by fission; cryptococcus cannot be so multiplied, "from the strength of its walls and hollowness of its centre," and it is therefore multiplied by gemmation. Micrococcus may be developed into higher forms in two ways :—

1. It may acquire a cell-wall, and pass on through the arthrococcal or cryptococcal stage to the formation of a fully-developed fungus.

2. It may under favourable conditions germinate at once, and give rise to mycelium.

In these views, as well as in those referred to above, Professor Hallier stands quite alone.

IV. *Preparations.*

1. Micrococcus. Professor Hallier exhibited numerous preparations, some of which he considered proved the development of micrococcus, and others its direct germination. In those showing development the field presented bodies like yeast cells mingled with granular matter; but of course no preparations could show that they were mere modifications of one another. In those showing germination there were also granules present, but in this case mingled with fine filaments; but one could not see definitely that these were organically connected. And as, generally, fully-developed fungi existed in the same preparations, one could not feel certain that the filaments were not mere detached portions of these, associated by mere juxtaposition with the granular matter.

Professor Hallier instituted a culture of scarlatina blood in our presence, in order, if possible, to demonstrate this development and germination of micrococcus. The small apparatus already described was used for the purpose. A drop of the blood being placed on a glass slide (the blood having been preserved for about three weeks in a closed test-tube), a little grape-sugar solution was added as a substratum, and a covering glass placed over it, the latter being separated from the slide by a perforated piece of thin cardboard, which had been soaked in alcohol. This preparation exhibited under the microscope numerous more or less disintegrated blood-corpuscles, associated with granular matter and numerous minute circular bodies, which Dr. Hallier described as being various stages of micrococcus. However, owing to the short period of our stay with him, no result whatever was attained.

2. Illustrative of the relation of moulds and ustilagines. Professor Hallier showed some preparations which, he considered, demonstrated the tendency on the part of mucor dilatations (*i. e.* macroconidia) to ripen into tilletia spores. These macroconidia presented a double contour, which he ascribed to a tendency to the formation of a cuticula. This condition was quite indistinguishable from the same appearance produced by the mere shrinking of the protoplasm, as

noted at Halle.—(Report of interview with Professor De Bary.) In several of these preparations some tilletia spores undoubtedly existed, but they were always merely lying among the other materials of the preparations, and their existence in such preparation might have been due to mere accidental entrance into the cultivation. The preparations were chiefly derived from cultivations in the large apparatus; therefore, of course, the separate steps in the development were not seen to take place.

3. Preparations illustrative of the tendency of penicillium to form dilatations resembling macroconidia. A great number of these preparations were exhibited, as, in Professor Hallier's opinion, they prove the identity of mucor and penicillium.

4. Rice-plant cultivations. Professor Hallier also showed his preparations illustrative of the condition of the rice-plants which he cultivated at Jena, watering the soil on which they grew with a solution of cholera evacuations. In order to develop the fungi affecting them, a portion of the leaf had been placed for some time on the surface of a mixture of starch paste with phosphate of ammonia, and small portions of the tissue of the leaf detached for observation. On examination, the tissue presented more or less globular bodies, apparently an exaggeration of spores, as figured in his work termed "Phytopathology." In this work Dr. Hallier speaks of the relation existing between these bodies and urocystis, judging from their form and method of germination. He seems now, however, to have abandoned this view of the relation of these bodies to urocystis; nevertheless he maintains that they are analogous to cysts found in cholera evacuations. Of course, in the absence of further details and of personal observations, it would be premature on our part (Ed. M. M. J.) to offer anything in the shape of critical comment on Professor Hallier's conclusions. But we must say that it strikes us that the magnifying powers employed in examinations involving decisions as to the development of Bacteria, and which seldom exceeded 250 diameters, were singularly low.—See *The Lancet*, Jan. 2nd, 9th, and 16th.

The Structure of Cartilage.—A paper has been read before the Vienna Academy of Science by Herr Bubnoff on this subject. He has found in the costal and articular cartilages both of man and other animals, that there exist singular ramifications of arteries, accompanied by veins, and he states that in some instances—illustrating as it were Reichert's law—that the cartilage cells can be traced into the muscular structure. The vessels are enclosed in special canals, lined with a layer of connective tissue. The articular cartilages are provided with a perichondrium, whose vessels penetrate into their substance. The action of hyperosmic acid reveals a complex network of canals, passing in all directions through the cartilage, and communicating with the lacunæ enclosing the cartilage cells—the so-called cells + the cartilage corpuscle.—*Vide Sitszungsber. d. K. Akad. d. Wissen.* LVII. Band IV. Heft.

The Stroma of the Ovary in Mammals has been examined by Herr Winiwarter, who, in a paper published in the Proceedings of the

Vienna Academy (LVII. Band V. Heft), states that he has found evidence of the presence of unstriated muscular fibre in the ovary.

The Structure of the Prostate Gland has been well investigated by Herr Teleky. In his published paper (Sitzungsber. d. K. Acad. d. Wissen, VII. Heft) he states that the ejaculatory ducts traverse the Prostate, and are surrounded on all sides with glands to the number of about 60 or 100. The largest of them is placed above and beside the centre of the lobes of the Prostate, and the shortest are situate externally below and behind. The structure of these glands differs essentially from the uniform type of gland. On transverse section of them is seen a row of papillæ covered with cylindrical epithelium, and the cells of this epithelium seem to penetrate into the connective tissue by means of filiform processes. Folds, or papillaform protuberances of the mucous membrane contribute to form a number of glandular pouches, and thus increase the secreting surface extensively. Each gland is surrounded by a capillary vessel, which sends branches to each of the papillæ.

The Muscular Structure of the Heart-valves.—Herr Gussenbauer, who has lately written a memoir on this subject, states that he has been able to confirm the results of Kürschner and others to the effect that the auriculo-ventricular valves contain muscular fibres. The presence of these fibres is, he says, by no means confined to the heart-valves of animals.

The Nervous System of Nemertes.—'The American Naturalist' for January contains, among other accounts of recent Scandinavian labours, by Dr. C. F. Lütken, a brief note on the recent researches of M. Boeck on the above subject. M. Boeck is the son of the professor of the same name in Christiania. He points out various errors committed by previous investigators, and demonstrates that the cerebral mass (or brain) is composed of an outer reddish granular substance and an inner yellowish filamentose one.

The Dermal Teeth of the Chondropterygii is the subject of an important memoir by Professor Hannover. The author has established —in reference to the microscopical structure and the development of these scales—four types of placoid dermal teeth, according to the form of the cells. These he styles respectively (1) conical, (2) knoll-like, (3) net-shaped, (4) bundle-shaped. In dealing with the dental structure of the dermal plates of Ostracion, a detailed description is given "of some very curious enigmatical comb-like corneous bodies preserved in the museums of Copenhagen, Christiania, and Kiel, but of unknown origin; from their resemblance in microscopical structure to the dermal spines of skates," the author is disposed to refer them to this group.—*Oversigt over det Kongelige danske videnskabener Selskabs Forhandlinger*, 1866 & 1867.

Formation of the Spores of Varicillaria.—'The Annals of Natural for December contain a translation of a short paper by Dr. ·t. This paper should be referred to by those ·als with. The author in part confirms the

observations of Tulasne and De Bary by observing that spores of Varicellaria when placed in a humid atmosphere throw out numerous slender circumradiant filaments. In addition to this he has seen other filaments arise from the "adjacent disrupted apothecium," and these constitute a sort of Penicillium which soon becomes destroyed and disappears. He has noticed that the spores when denuded of the filaments of Penicillium, displayed in the interior of each cell a white corpuscle which "towards the septum separating the cells, in most spores stretched out the sporal wall on one side. Thence I sometimes saw a white oblong corpuscle spontaneously expelled from either cell. When free these corpuscles became larger and especially longer than when enclosed within the spore, somewhat deformed and unequal, or almost cerebriform on the surface but covered by no cellular membrane." This the author thinks is the beginning of the thallus of the lichen.

American Observations on Nobert's Test-plate, and How to Count the Lines.—Those interested in the resolution of Nobert's lines will find two very interesting papers on the subject in the last number of 'Silliman's American Journal of Science' (No. 138, Second Series). The first paper is by Mr. W. S. Sullivant, and comments on Mr. Stodder's paper on the "American Naturalist" for April last. The footnote to this paper deserves notice. The author, speaking of Dr. Woodward's photographs, says, "The first fifteen bands are sharply and clearly resolved into the *true* lines; the fifteenth band, however (which is ruled to the 90,000th of an English inch) requiring a hand-glass magnifying four or five diameters to show its lines distinctly." Mr. Sullivant makes a suggestion, too, which we should take into consideration—it is that an eager observer may be pushed by his imagination to see almost anything that he desires to perceive. The second paper, by Dr. and Col. Woodward, contains matter already brought under the notice of the Royal Microscopical Society. The following directions for counting the lines in the highest bands that can be resolved may be useful:—"If a cobweb micrometer is used, the micrometer eye-piece should be firmly clamped in a stand screwed to the table, so that the eye-piece is close to the end of the microscope-tube, but does not touch it—a piece of black velvet being used to complete the connection. The motion of the micrometer-screw now communicates no tremor to the microscope, and all difficulty in counting the lines seen (whether real or spurious) disappears." Still better than this is the following method:—The microscope being set up in a dark room, as though to take a photograph, and the eye-piece being removed, the image of the band to be counted is received on a piece of plate-glass in the plate-holder, and viewed with a focussing-glass, on the field-lens of which a black point is marked; as the focussing-glass is moved on the plate from side to side, the black point is moved from line to line. The lines may thus be counted with as much ease and precision as though they were large enough to be touched with the finger.

NOTES AND MEMORANDA.

Note on Desmidiaceæ of Greenland.—It is a curious and noteworthy fact that the Desmidiaceæ are apparently as cosmopolitan in their range as the Diatomaceæ, the same forms being found flourishing under tropical heat and Arctic cold. Without exactly knowing why it should be so, an opinion has nevertheless become general amongst algologists, that there is something in the physical constitution of the Diatom—perhaps its being protected by the more enduring wall of silex—which enables us to predicate a greater power to resist the effect of climatic change in it than in the Desmid. The opinion is, however, erroneous; for although my attention whilst in Greenland, in 1860, was directed too exclusively towards marine natural history to admit of my devoting much time to the collection of land and fresh-water objects, on one occasion I obtained no less than twenty-seven species of Desmidiaceæ. These were found near Goodhaab on the west coast, in lat. 64° N., in fresh-water pools, at elevations varying from 1 to 400 feet above the sea-level. They were growing so plentifully that the entire number was gathered by a single dip in each spot of my collecting-bottle. In size the specimens were certainly somewhat inferior to that of similar species met with in more genial climates. But otherwise, as regards luxuriance of growth, the rate and extent to which the paradoxical multiplication by division appeared to be taking place, and the brilliance of the green colours of the Chlorophyll, there was no inferiority whatever. The period of the year was the middle of August, when during two or three hours about midday, the sun's heat is very great even in these boreal latitudes; but this only makes the circumstance the more wonderful, inasmuch as the temperature, for at least twenty out of the twenty-four hours, is very low indeed, and there was at that time abundance of ice on the fiords and upon the heights. The pools from which the gatherings were made were said to be completely frozen up for the greater portion of the year; so that the period of active vitality and reproduction, although limited in this extraordinary manner, must nevertheless suffice for the continuance of the species. The following is a list of the Desmidiaceæ referred to—

Hyalotheca dissiliens.
Didymoprium Borreri.
Sphærozosma excavatum.
Euastrum didelta.
" *elegans.*
" *binale.*
Cosmarium crenatum.
" *pyramidatum.*
" *Menegheni.*
" *Botrytis.*
" *margaritiferum.*
" *binoculatum.*
Staurastrum polymorphum.
Staurastrum Dickieii.
" *brachiatum.*
" *echinatum.*
" *var. nov.*
" *dejectum.*
" *cuspidatum.*
Arthrodesmus incus.
Xanthidium cristatum.
Tetmemorus Brebissonii.
Penium Brebissonii.
Closterium Dianæ.
" *var. nov.*
Arthrodesmus falcatus.

Together with a new filamentous genus, and a form like *Holocystis*, but with central granular inflation. G. C. WALLICH, M.D., F.L.S.

Ross' Microscopic Vice.—Mr. Ross requests us to correct an error made by one of his assistants in the lettering of the figure illustrating his microscopic vice in our last number. At page 58, the letter C in the diagram is misplaced, and should hold the position it does in the adjacent cut.

Woodward's Heliostat.—Mr. T. Higgins, of Liverpool, sends us the following note:—"Some of the readers of 'The Monthly Microscopical Journal' will, I have no doubt, be glad to know where they can obtain Heliostats of Dr. Woodward's form, as given in your last issue. Dr. Woodward kindly sent me a drawing and description last summer, which I put into the hands of Messrs. Abraham & Co. here, and they have made some excellent instruments. I have one which works to my entire satisfaction."

The Professorship of Botany in Trinity College, Dublin.—Our readers will be glad to learn that the chair which Dr. Harvey held for so many years, and which was till recently occupied by Dr. Dickson, has been given to Dr. Edward Perceval Wright, late lecturer on Zoology in Trinity College. No more worthy candidate could have been selected for the post. Dr. Wright is not only an accomplished naturalist in the widest sense of the word, but to an appreciation of the general philosophy of Biology, he adds a wide experience in botanical and physiological research, an acquaintance with the Flora of his own country (the result of many years' investigation), and a power of expressing his opinions which must make him highly popular as a lecturer. Dr. Wright was one of the founders of the old 'Natural History Review,' which was originally a Dublin journal. He was one of the most active members of the Natural History Society of Dublin, as he is now one of the most industrious supporters of the Dublin Microscopical Club. He is also one of the editors of the 'Journal of Anatomy and Physiology,' and has charge of nearly all the Invertebrate departments in 'The Zoological Record.' It is unnecessary to refer to his numerous contributions to scientific literature, as microscopists are thoroughly familiar with them, and they are to be found in the different journals devoted to natural science. We congratulate the University of Dublin on the wise discrimination it has exercised in selecting Dr. Wright for the vacant office.

Dr. Maddox's Paper in our last Number.—As we omitted to give the original diameters of the figures in Plate I., illustrating Dr. Maddox's paper in our last number, we may state that several of the drawings and photographs were very considerably reduced by the engraver. We call attention to this now, as some of the points of interest could not be seen correctly were the objects viewed at the amplifications appended in the plate, and as the original drawings and photographs were of great size and very beautiful.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.†

December 13.

James Glaisher, Esq., F.R.S., President, in the Chair.—Minutes read and confirmed. Presents and donations. Thanks of the meeting were given to Mr. Baker for loan of microscopes and lamps. A series of pen-and-ink drawings of parts of insects magnified, drawn by Mr. A. Hammond, were exhibited by M. Moginie, to whom thanks were voted. Mr. Joseph Beck exhibited a new rotatory stop adapted to his best microscopes. This was explained to be a modification of that adopted in the 'Popular Microscope.' The pinion giving the slow rotation movement could be thrown out of gear by a simple motion, and then the rotation could be made rapidly by hand. The edge of the stop is graduated for reading off angles, and underneath the stop is an iris diaphagm, moving upon a hinge.

The following papers were read:—By Dr. Charlton Bastian, F.R.S., "On the Mounting and Tinting of Animal Tissues."‡ Remarks on the importance of the method and experiments detailed were made by the President, Dr. Lankester, Mr. Jabez Hogg, and Dr. Murie.

By Mr. McIntire, "On the Scale-bearing Poduræ."

Dr. Lankester gave notice of his intention to move an alteration in Bye-law 56.

On February 10, the Annual General Meeting for the Election of Officers will be held. The President will deliver an address.

Donations to the Library, January 13, 1869:—

	From
Land and Water. Weekly	*Editor.*
Scientific Opinion. Weekly	*Editor.*
Society of Arts' Journal. Weekly	*Society.*
Transactions of the Linnean Society. Vol. XXVI., Part 2	*Society.*
Popular Science Review	*Editor.*
The Student	*Publisher.*
Chemical Geology of the Gold Fields of California, by J. A. Phillips	*Author.*
Journal of the Quekett Club	*Club.*

Walter W. Reeves,
Librarian, &c.

The following gentlemen were duly elected Fellows of the Society:—

George Acland Ames, Esq.
The Rev. Thos. R. Jones, M.A.

Walter W. Reeves,
Assistant-Secretary.

* Secretaries of Societies will greatly oblige us by writing out their reports legibly—especially the technical terms—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

† Report furnished by the Secretaries.

‡ This paper appears elsewhere in our p[illegible] Ed. M. M. J.

Quekett Microscopical Club.

At the ordinary Meeting held at University College, December 18th, 1868, Arthur E. Durham, Esq., F.L.S., &c., President, in the chair, sixteen new members were elected, and nine gentlemen were proposed for membership; a number of presents to the library and cabinet were also announced, and the thanks of the meeting returned to the respective donors. A paper was read by Mr. John Hopkinson, "On the British Graptolites," the subject being illustrated by sixteen diagrams and numerous classified specimens. The author, after indicating their position and range in the geological series, briefly described their structure, and traced the history of the various observations which from time to time had been made upon them; their classification, zoological position, and mode of growth were also noticed, and the distinctive characteristics of the various families were pointed out upon the diagrams. The paper was concluded by a reference to the fact of the complete extinction of the race, and its re-creation after a lapse of time, the inferences from which were held to be unfavourable to the well-known theories of Mr. Darwin. Some further observations upon the subject were made by Mr. W. H. Leighton, who drew attention to the four chief divisions of the graptolites, and to the great distinguishing difference between them and the asterida (!), to which at first sight they appeared to bear a close resemblance. A vote of thanks to the reader of the paper was unanimously carried.

Mr. Samuel Roberts exhibited and described a new form of micrometer to be used with the monocular microscope; it consisted of a separate tube mounted on a stand, and placed by the side of the instrument in such a position that the left eye could look directly down it, whilst the right was observing through the eye-piece in the ordinary way. Proper illumination being applied, the object on the stage was seen with one eye, whilst the micrometer ruling appeared to the other, the practical effect being to superpose the two images. A short discussion as to the merits of this contrivance ensued, after which the President announced that the arrangements for the formation of a class for microscopical manipulation, under the direction of Mr. W. T. Suffolk, were now completed, and the class would meet on six alternate Thursday evenings, commencing in January, at the rooms at 32, Sackville Street. Mr. Suffolk intimated that he should be happy to receive material for the use of members of the class, and would also be glad of the assistance of any gentlemen who had attended his former courses. At the close of the meeting, a quantity of unmounted microscopical specimens, presented by Mr. J. R. Eldridge, were distributed amongst the members, and at the usual conversazione which terminated the proceedings, a number of highly interesting objects were exhibited.

On January 8th, the second of the winter series of conversational meetings was held, and was very largely attended, between seventy and eighty members being present during the evening,

about twenty microscopes were brought, and a very pleasant evening was spent in the discussion of the various objects exhibited under them.*

Literary and Philosophical Society of Manchester.

Ordinary Meeting, December 29th, 1868.—E. W. Binney, F.R.S., F.G.S., Vice-President, in the chair.—"Note on the Organs of Fructification of *Calamodendron*," by E. Binney, F.R.S. In my paper on *Calamodendron*, published in vol. xxi. of the 'Transactions of the Palæontographical Society,'† is figured and described a plant with organs of fructification attached to it from the lower Brooksbottom seam of coal near Ewood Bridge, in the county of Lancaster. The plant consists of a stout stem, having traces of ribs and furrows, and seven joints at which knots appear. From these last-named parts, on each side of the stem, are seen to proceed seven cones, all about half-an-inch in length, springing outwards in nearly a horizontal direction in the specimen. These cones do not show any trace of a central axis; but are composed of crown-shaped masses, most probably of sporangia, contained in receptacles arranged around an axis. Eight or nine of these can be seen in one cone. Unfortunately, the specimen being in soft shale, no evidence can be obtained of its internal structure, so as to ascertain if the sporangia contained any spores. If this is not the same plant as Geoppert's *Aphyllostachys Jugleriana* it is very closely allied to that plant.

Mr. John Aitken, of Bacup, furnished me with the specimen. At the time the Monograph was published my opinion was that the only point in which the specimen differed from that figured and described by Ludwig of the fruit of *Calamites* in Dunker and von Meyer's Palæontographica, vol. x., 1861 to 1863, was that it only possesses eight to nine receptacles or cells against his fifteen to sixteen.

Since that time Captain Aitken, of Irwell Vale, and Mr. John Aitken, have been so good as to conduct me to the place where the specimens were found, and I have collected myself far more perfect and complete specimens than those which had previously come under my observation.

In both Ludwig's and Geoppert's specimens the cones or organs of fructification, like the leaves, were arranged in whorls at each node of the stem. The same arrangement was observed by me in the first specimen from Ewood Bridge which came under my observation. Now, although that appears to have been the more common form of attachment of the cones to the stem, there is undoubted evidence that some of these organs occurred at the extremity of the branches ornamented with whorls of leaves at their nodes, as is seen in the fructification of the common *Equisetum*.

The number of receptacles or cells containing sporangia in the first specimens I met with were eight to nine in number, but I have since found individuals with fifteen to seventeen, showing therefore that the Ewood Bridge specimens have a greater resemblance to Ludwig and Geoppert's than could be then proved.

* Report supplied by Mr. R. T[illegible]

† P. 27.

The cones, whether proceeding from the nodes of the stem in whorls, or at the end of the branches, have at their bases delicate leaves (*Asterophyllites*). The stem of the branch to which the cone is attached in the last-named specimen is remarkably slight for the size of the cone, a character which appears very common with regard to the organs of fructification of coal plants at the end of branches. Of course, the axis of the cone is only a prolongation of the stem of the plant. In the Ewood Bridge specimens as yet no evidence has been obtained as to the spores contained in their sporangia to identify them with the cones of *Calamodendron commune*; but as to their external characters, the one very much resembles the other, and although found in different localities, the fossils occupy about the same geological position in the Lancashire Coal Field. One thing appears pretty certain, namely, that these small cones are organs of fructification of *Calamites* of some kind, and at present my observations lead me to the conclusion that they are the organs of fructification of the *Calamodendron commune*, or a plant very nearly allied to it, and having a similar structure. They do not afford us any information of the anatomy of the plant like my coal specimens; but they show us the characters of the leaves, and the connection of the organs of fructification with the stem of the plant.

January 12*th*.—E. W. Binney, F.R.S., F.G.S., in the chair.—Mr. Binney said that at the meeting of the Society on the 1st December last, he brought before the members the valuable discovery of Professor Adolphe Brongniart of a fossil cone, containing both microspores and macrospores, and showed that it belonged to a plant of the carboniferous epoch. It has long been supposed that *Lepidostrobus* was the fructification of *Lepidodendron*, but no further evidence of the fact had been adduced than that which Dr. J. D. Hooker, F.R.S., had given, by finding the cones in the insides of *Lepidodendron Harcourtii* and *elegans*, which could only be considered of a very unsatisfactory nature. In a cone in the author's possession, in every way similar to the late Dr. Robert Brown's celebrated specimen of *Triplosporite*, but having the column in a more complete state of preservation, there is most conclusive evidence from internal structure that the *Triplosporite* is the fruit of *Lepidodendron Harcourtii*, the pith vascular cylinder, vascular bundles communicating with the leaves or scales, and the outer cylinder being the same in the cone as in the stem, thus justifying Mr. Carruther's opinion that the cone was a *Lepidostrobus*. The large spores found in a *Lepidostrobus* described by Dr. Hooker in the 2nd volume of the Memoirs of the Geological Survey, as well as similar specimens found by the author in coal at Wigan, and described in the 'Quarterly Journal' of the Geological Society for May, 1849, are most probably both macrospores of the fructification of *Lepidodendron*, and having come from the lower portion of a cone, whilst Dr. Brown's were from the upper part. The same may be said of Professor Morris' specimen, belonging to Mr. Prestwich, from Colebrook Dale, described and figured in Vol. V. of the 'Transactions of the Geological Society,' published in 1840, which clearly came from the lower portion of a cone of *Lepidodendron*.

In the new genus *Flemingites*, described and figured by Mr. Carruthers in Vol. II. of the 'Geological Magazine' for October, 1865, there are two kinds of sporangia, those in the upper part of this long and slender cone being something like the sporangia of the *Lepidodendron*, but arranged in whorls, and probably filled with microspores, whilst the lowest scales supported sporangia, containing macrospores. This the author gathered from much more perfect specimens than those which Mr. Carruthers had to work upon. Most certainly the little flattened discs which he described as sporangia, are found on scales at the base of the cone, and not in the middle or upper portions of it, as many of the author's specimens clearly prove. When Professor Brongniart's paper is published and drawings of his specimen are given, we shall be better able to understand the relation of the genus *Flemingites* to *Lepidodendron*.

Microscopical and Natural History Section of the Manchester Literary and Philosophical Society.

January 4th, 1869.—J. B. Dancer, F.R.A.S., President of the Section, in the chair.—Mr. Spencer H. Bickham, jun., and Mr. James Higgin were elected members of the Section.—Mr. A. G. Latham exhibited a beautiful set of microscopic slides, and read a short paper in illustration of the various organs and orders of Fungi. The paper was accompanied by Tulasne's fine work, entitled 'Selecta Fungorum Carpologia,' and was further illustrated by a set of Cooke's "Fungi Brittanici exsiccata."—Mr. Thomas Coward exhibited specimens of the following Willows from the Tyrol, considered to be hybrids, and of the supposed parent species:—Salix macrophylla, Kerner, between S. grandifolia, Sering, and S. Caprea, L. Salix calliantha, Kerner, between S. purpurea, L., and S. daphnoides, L. Salix spuria, Schleich, between S. arbuscula, L., and S. helvetica, Schl. Salix Huteri, Kerner, between S. helvetica, Schl., and S. hastata, L. Also three very distinct forms of S. nigricans, Sm.—A selection of Proteaceæ, principally from Drummond's Australian Collections, referred to by Meisner in De Candolle's Prodromus, was also exhibited as illustrating the combination of great variety of form, especially in foliage and fruit, with a well-defined ordinal character. It was suggested that the varieties of our common indigenous plants were still worthy of the careful examination of botanists, especially in relation to those physiological aspects to which attention has been directed by Mr. Darwin's inquiries and reasonings respecting the propagation and permanence of aberrant organic forms.—Mr. Charles Baily distributed specimens of Scripus parvulus R. and S., collected by himself, in August last, at its newly discovered station in Wicklow. The plant grows in abundance near the harbour of Arklow, at the mouth of the river Ovoca, on large sandy flats, which are covered by each tide. Very few plants were met with in flower, and not a single specimen in fruit, and the plant is propagated by minute pear-shaped underground buds, whose tapering ends are somewhat recurved. Mr. Bailey pointed out the specific

characters of the plant, and mentioned that it could be most readily identified by the porcelain-like appearance of the lower part of the culms.—A paper by Mr. E. Heelis, Dimbula, was communicated by Mr. H. A. Hurst, entitled "Ceylon: its Climate, Natural History, &c." The paper included many interesting facts having reference to the zoology, botany, and geology of the central portion of the island.—Mr. J. B. Dancer, F.R.A.S., exhibited a series of microscopical slides, consisting chiefly of the leaves of tropical plants.

Reading Microscopical Society.

15th Dec., 1868.

The usual monthly meeting was held at the Athenæum, Captain Lang presiding.

The ordinary business having been transacted, the President reminded members of an old custom of entering, upon a paper lying upon the table for that purpose, the names of objects brought for exhibition; and suggested that it should be resumed.

Mr. F. J. Blandy then read, "Some Remarks on the History of the Development of Infusorial Animal Life," in which he referred to the opinions, experiments, and conclusions of Aristotle, Lewes, Carpenter, Schultze, Pouchet, De Quatrefages, and others, as to spontaneous generation and the existence of Infusoria under most unlikely conditions.

Mr. Tatem exhibited an unrecorded form of Infusorium,* for which a new genus would have to be founded.

Microscopical Society of Liverpool.

The first meeting of this Society was held at the Royal Institution, on Tuesday, January 5; Dr. Thomas Inman was elected Vice-President and Mr. W. M. Bywater an Honorary Member.

The list of members was read by the Secretary, Mr. C. H. Stearn, after which the inaugural address of the session was delivered by the President, Dr. J. Birkbeck Nevins.

After commenting on the advantages to be derived from co-operation and intercourse between workers in the same branch of science, Dr. Nevins dwelt at some length on the reasons that had induced this Society to depart from the usual practice of scientific associations by admitting ladies as members.

He pointed out the necessity of hard work and careful observation in order to attain proficiency in Microscopy, and what valuable work might be done by the use of low powers and inexpensive apparatus. Dr. Nevins concluded by directing the attention of microscopists to the important problem of the origin of epidemic disease, and recommended a careful examination of the constituents of the atmosphere in time of health and at all periods of the year.

After a vote of thanks to the President for his excellent address, the meeting resolved itself into a *conversazione*.

* Described in Mr. Tatem's communication in this number.—Ed. M. M. J.

The objects exhibited were divided into sections and were illustrated as follows:—

Anatomy and Physiology	*T. Inman, M.D., T. S. Walker, M.R.C.S., J. Newton, M.R.C.S.*
Vegetable Tissues	*Rev. W. Banister, B.A.*
Vegetable Circulation	*G. F. Chantrell.*
Living Objects	*J. Abraham, T. G. Moore, Cor. Mem. Z.S.*
Diatomaceæ	*Arthur C. Cole, Lewis Hughes.*
Raw Fabrics	*W. Carter, M.B., B. Sc., LL.D.*
Adulterations in Exciseable Articles ..	*R. Connor.*
Seaweeds	*S. L. Gregson.*
Insect Dissections	*W. J. Baker, J. Henderson.*
Foraminifera and Polycystina	*W. H. Weightman.*
Micro-Chemistry	*C. F. Salt, E. Davis, F.C.S.*

Mr. Cole exhibited Möller's Diatom Tpe Slide, which had been kindly lent for the occasion by Mr. Curteis, and a slide of exquisitely arranged Diatoms prepared by himself.

Messrs. E. Davis and C. F. Salt exhibited slides of sulphate of copper, spirally crystallized at different temperatures.

Mr. J. Abraham exhibited *Melicerta ringens, Floscularia ornata, Fredericella sultana.*

Mr. J. T. Moore exhibited specimens of *Vorticella* and *Hydra* from the aquaria of the Free Museum, and some Nudibranchiate spawn from the Mersey.

Dr. Inman exhibited the Sclerotic of a bird's eye and a longitudinal section of the eye of an insect.

Mr. Walker exhibited a transparent injection of the iris and ciliary processes.

Brighton and Sussex Natural History Society.

January 14.

A paper "On Flint" was read by Mr. T. W. Wonfor, Hon. Sec.

After describing Flint and discussing the various theories respecting its origin, Mr. Wonfor pointed out the utility of the microscope in geological research, in fact, that a new phase of geological inquiry had been opened out by the examination of thin sections of rocks. Not only had it been shown beyond doubt that flint had been formed by the infiltration or deposit of soluble silicates or organisms, such as sponges, corals, &c.; but thin sections of flint, under the microscope, revealed the presence of foraminiferæ, sponge spicules, Xanthidia, believed by some sporangia of Desmidiæ, &c.

Infiltration and deposit of silex held in solution was still going on, as seen in the Geysers of Iceland and the waters of the Danube, while animal and vegetable organisms possessed the power of taking up silex, as seen in sponge spicules, the beautiful *Hyalonema* and *Euplectella*, the siliceous cuticles of many plants, and the Diatomaceæ, favourite objects with microscopists.

Old Change Microscopical Society.

Charles J. Leaf, F.L.S., &c., the President, in the Chair.

At the monthly meeting of this Society, held Jan. 15th, Major Owen, F.L.S., delivered a lecture "On Polycystina," which was illustrated by numerous specimens and drawings.

Mr. C. T. Richardson, one of the members, also read a paper "On Floscularиæ."

The Third Annual Soirée of the Society will be held Feb. 15th, at the Terminus Hotel, Cannon Street.

Natural History Society of Armagh.

The last meeting of this Society was held on the 13th January, Mr. A. J. Mulligan in the chair. Mr. Lewis G. Mills, LL.B., delivered a lecture "On the Manipulation and Preparation of Objects for the Microscope." The lecturer stated that of the large number of those who possessed microscopes, but few were able to prepare good slides, and these persons were chiefly dependent upon professional preparers for properly mounted objects. He then showed how that such unskilled preparers might turn their microscopes to good account by using them in the study of objects which required little manipulation and no preparation. The lecturer then gave a lengthened explanation of usual methods adopted in the preparation of microscopic objects of different kinds. In speaking of the mode of mounting diatoms from fossil deposits, he strongly recommended the method of selection as giving the best attainable results from unpromising deposits. His observations on the treatment of guano were to this effect:—"The guano most readily obtained is the common Peruvian guano of commerce; in this deposit the diatoms form a very small percentage of the entire mass, and to prepare the deposit for mounting in the rough, according to the usual process, would generally give very poor results, and discourage all except those well skilled in manipulation. However, the most unproductive samples of guano contains some diatoms, and fair slides may be prepared from the material, if the process of selection be adopted in their preparation. For this process, it is not needful to use more nitric acid in the previous cleaning than that which may be necessary to clean the diatoms themselves; and the use of sulphuric acid and chlorate of potash is not required, as the bleaching of the unsightly foreign material would be useless. A large drop of the prepared material must be spread near the edge of a glass slide: the appearance of this under a simple microscope with a glass of one-inch focus will be that of much dirty material containing a few clean diatoms: the best of these latter may be pushed out of the water by means of a needle, and nicely arranged near the centre of the slide. The slide may now be raised, and the water may be carefully wiped off; the turning of the slide on its edge, or the wiping away of the water will not disturb the diatoms selected and placed, as they remain attached to the glass sufficiently firmly to admit of the movements required. In this way the choice diatoms may be selected out of many drops,

and be perfectly free from an unsightly speck of the half-cleaned foreign material. The diatoms to be obtained from Peruvian guano will vary, within certain limits, with the different samples of the guano. The common forms of *Coscinodiscus* may always be found; *Eudycta oceanica* often; *Aulacodiscus scaber* frequently; sometimes *Auliscus peruvianus* may be obtained. From many different trials I found twice a form which I take to be *Aulacodiscus Petersii*, and once only *Auliscus ovalis*. These I have on clean slides, and for them and the clean mounting I believe I am indebted to the process of selection which I have endeavoured briefly to describe, and but for which process the material from which they were taken might have been thrown away as useless. It is needless to say, that in deposits where the diatoms are small and very numerous, as also in pure gatherings of living diatoms, the process of selection is out of the question; but in working the Moron deposit, the different kinds of guano, shell-cleanings, and others, it will be found to be of the greatest utility."

Dr. Riggs moved a cordial vote of thanks to the lecturer, and passed a warm eulogy on his able address, which was seconded by Mr. Osborne, and carried with acclamation.

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THE

MONTHLY MICROSCOPICAL JOURNAL.

MARCH 1, 1869.

I. THE PRESIDENT'S ADDRESS.

(*Delivered before the* ROYAL MICROSCOPICAL SOCIETY, *February* 10, 1869.)

GENTLEMEN,

At the close of a Presidency prolonged by your kindness to twice the usual term, I have the satisfaction of leaving the affairs of the Society in a flourishing and hopeful state.

During my period of office important changes have been brought about. We have obtained, through the acquisition of a Royal charter, a higher standing for the Society. By that circumstance, and by the activity with which our business has been conducted, the value of the papers read before us, and the impulse we have given to microscopical science, we have, I think, established a claim to receive from the Government accommodation equal to that which they have provided or undertaken to provide for other similar bodies. I trust my successor will be able to obtain its practical recognition.

As a chartered Society we were able to raise the very low terms of subscription at which Fellows were formerly admitted; and as our numbers increase at the new rates of subscription, we shall be able to do more for science, and carry out many plans for the good of the Society, which our restricted income has hitherto postponed. I shall proceed to lay before you the principal facts of our present condition; but first in order, as is customary, I have to speak of our losses by death during the past year, and the number we have to regret is more than usual, being no less than seven; *viz.*—Nathaniel Bagshaw Ward, William Bird Herapath, Henry G. Wright, Henry Sidden, John W. Griesbach, William Milner, and Henry Rutt.

Nathaniel Bagshaw Ward was born at Plaistow, in Essex, in the year 1791, and died on the 4th of June, 1868; he was therefore in the seventy-seventh year of his age. His father was for many years in practice at Plaistow, where Mr. Ward's early life was spent, and where he pursued the study of botany with the greatest perseverance. Afterwards he practised as a surgeon in Wellclose Square, where he made the discovery which led to the

adoption of the closed glazed cases for the transmission of plants from one part of the world to another, and which have been the means of introducing the tea plant for cultivation into Assam and the Cinchonas, into India, as well as enriching our conservatories with the choicest productions of nature.

It was whilst at Wellclose Square, that he held evening parties for microscopical research, and it was at these meetings the first idea occurred which led to the formation of this Society, to which for many years Mr. Ward acted as Treasurer.

He was a Fellow of the Royal Society and of the Linnæan Society; and from an experience of more than twenty years, I can testify that he was indeed a warm and kind friend.

[The President then read from the 'Gardener's Chronicle' Dr. Hooker's well-deserved eulogy of Mr. Ward, with remarks of the services rendered by the "Wardian case."]

Dr. William Bird Herapath, born in 1829, was the eldest son of the late Mr. William Herapath, of Bristol, the well-known toxicologist and professional analyst, whom he only survived eight months. For some years he assisted his father in the laboratory and at the medical school. He displayed precocious talents for chemistry, evidenced by the various public lectures he delivered when only from fourteen to nineteen years of age. Having studied at the Bristol Medical School and London Hospital, he took the M.B. degree of the University of London in 1844, passing with honours in no less than six different branches, and seven years later he became an M.D. of the same body. He was also a Member of the Royal College of Surgeons. For some years he acted as surgeon to St. Peter's Hospital (the Bristol poorhouse), and later he was medical attendant to various schools under the British Charity Trustees, and medical referee to several assurance companies. His practice was extensive and successful, and his diagnosis marked by much shrewdness and penetration.

How sincerely he was regretted by the humble classes was evidenced by the sympathizing throngs who lined the streets as he was borne to the grave. He communicated to various medical societies, and to the pages of the 'Lancet,' 'Medical Times,' and other journals, numerous valuable papers on pathological and professional subjects; and of late years was much employed in causes requiring toxicological or chemical evidence, for which his wide range of attainments peculiarly fitted him. At the Meeting of the British Medical Association at Bristol, in 1863, he delivered an address on "Chemistry in its relations to Medicine," marked by much originality of thought and eloquence. He was early elected a Fellow of the Royal Society of Edinburgh, and in 1859 the Fellowship of the Royal Society of London (a distinction which he greatly coveted) rewarded his brilliant series of "Researches on

the Iodo-Sulphates of the Cinchona Alkaloids." By a happy accident, in the year 1851, some tincture of iodine became mixed with the solution of disulphate of quinine in his surgery dispensing-bottle. The result was the formation of a crop of crystals of the curious substance since aptly named "Herapathite" by Professor Haidinger. Struck by their peculiar appearance, Dr. Herapath devoted himself to their examination both chemically and optically, which he worked out with such masterly skill and precision, that his series of papers on the subject may be looked upon as models of chemico-physical research. These "artificial tourmalines" would have been of greater practical value in the construction of polariscopes, but for the difficulty in obtaining perfect films of adequate size.

The claims of a large family and the calls of an exacting and harassing profession left Dr. Herapath but scanty leisure to devote to his cherished scientific pursuits, and it was only his remarkable energy and perseverance, and the sacrificing needful rest, that enabled him to accomplish what he has done.

In his brief holidays by the sea-side he entered zealously on the study of marine organisms, especially the Echinodermata, papers on which, illustrated by numerous micro-photographs, he read at the Bath Meeting of the British Association in 1864, and which have since appeared in the 'Quarterly Journal of Microscopical Science.' He was also an able botanist and entomologist. All through the trying summer of last year, when his health was fast failing and his professional calls were increasingly pressing, he devoted much labour to the spectroscopic observation of the chlorophyll of various plants, the unfinished results of which have not yet been published. He died unexpectedly, on the 12th of October last, of jaundice, complicated by diabetes and disease of the heart, after only a week's illness, at the comparatively early age of forty-eight.

In character Dr. Herapath was singularly generous and open-hearted, and frank and genial in manner. To his patients, rich or poor alike, he was most kind and considerate, and he was ever ready to assist all in matters scientific or otherwise; while of intellectual pride and assumption or professional jealousy he had no trace.

Henry G. Wright, M.D., F.R.M.S., &c. By the premature decease, in his forty-first year, of Dr. Henry Wright, of Harley Street, the profession in London loses one of its most accomplished and gifted members. Remarkable for social brilliancy, for wit, literary culture, and most amiable personal qualities, he was one of those who in this metropolis widen the reputation and deepen the hold of their profession by the possession of accomplishments which all can appreciate, and of the literary culture which adorns any profession.

"Dr. Wright was educated at a public school in Gloucester; commenced his medical studies in Hereford Infirmary, and pursued them in Edinburgh and Paris. He graduated as M.D. of Edinburgh in 1851, and obtained subsequently some minor hospital appointments. Later, Dr. Wright was appointed Physician to the Samaritan Hospital—an appointment which, with others, he held at his death. As a medical author he was best known by his little book on 'Headaches, their Causes and their Cure,' which has gone through many editions; and by his later elaborate, learned, and beautifully written treatise on 'Uterine Disorders, their Constitutional Influence and Treatment.' Some of his best writings were anonymous. Those who remember the "Annotations" of the 'Lancet' when they were first started, and did so much for the reputation of that journal—brilliant, witty, and learned notes, in every line of which there lurked a joke, a sarcasm, or a counsel, barbed or sheathed in classic guise—will have the best idea of his happiest and most effective style.

"Some of his contributions to the 'Saturday Review' have been remarkable for their strength and brilliancy of style and thought. A chosen friend of Jerrold, Thackeray, and many of the wits past and present, and an able satirist, he was a man of gentle instincts, kind heart, and generous forbearance. Few men of the like literary habit have made more friends and fewer enemies. As a physician, he was judicious, kind, discriminating, and successful. He had conquered for himself a position in practice, and in the profession which men "out of the hospital groove" find it very difficult to acquire. He died at a moment when happy marriage, worldly success, and the esteem and affection of many friends had made life very smooth for him and its prospects very fair. His resignation and gentleness during an illness of some months (pleurisy, followed by empyema) were very touching. He was for many years a Member of Council of the Photographic Society, and afterwards a Vice-President, acting with me all the time. His paper on the Medical Uses of Photography, the last of which was read two years ago, exhibited a large amount of enthusiasm in his profession."*

I have not been furnished with biographical particulars of the remaining Fellows, whose loss we have to regret.

The President then read a Report of the Library Committee, to the effect that the books were generally in a good state, that the catalogue required revision, and that more extensive purchases were very desirable to make the collection more useful for purposes of reference. He observed that to accomplish this purpose and to add a lending branch to the library, it would be necessary either to

* 'British Medical Journal.'

create a special fund, or to resort to one already at the Society's disposal. He said:—

"The Treasurer's accounts show that there is on hand a balance of the Charter Fund, which might be devoted to this important object. I do not think it would be in accordance with the feelings of those who subscribed to that fund, that it should be dissipated in current expenses; but few, if any, would object to an appropriation of the balance to a useful purpose of a permanent and enduring description, but I should prefer the creation of a special fund applicable to this purpose—of forming a lending branch of the Library."

The Report of our Microscope and Cabinet Committee records a donation of a $\frac{1}{20}$ object-glass, by its maker, Mr. James Smith, jun., and of an achromatic condenser with various combinations, by Mr. Swift. Mr. Heisch has also presented us this day with a handsome binocular microscope, embodying the improvements he has effected in M. Nachet's plans.

In 1868, at the time of our annual meeting, we had 2674 objects in the Society's cabinets. That number had at our last meeting increased to 3232, to which we may now add an important series of 144 slides, presented by Dr. Bastian, illustrating the annelidæ, and nine slides, presented by Dr. Carpenter, illustrating his recent deep-sea dredgings. The largest donation of the year was made by Mr. Joseph Beck, of 424 sections of bones and teeth, in a handsome mahogany cabinet. The total number of our slides is now 3385.*

The cabinet of objects is being entirely rearranged under the superintendence of Dr. Murie, who has kindly given his valuable aid.

I now come to a very important question; *viz.* the arrangements which have been made for the publication of the Society's transactions and proceedings.

* The List of Donations for the year is given as follows in the Cabinet Committee's Report:—

By T. Charters White, Esq.	5 Slides of Sections of Stag's Horn, with Blood Vessels, and 5 Slides of Hippuric Acid.
" W. M. Bywater, Esq. ..	24 Slides of Indian Bat's Hair.
" Joseph Beck, Esq. ..	424 Sections of Bones and Teeth, in a handsome Cabinet.
" J. Norman, Esq.	7 Slides of Crystals; 32 Slides of Eggs of Lepidoptera.
" E. Harrop, Esq.	6 Slides of Objects from Tasmania.
" S. J. McIntyre, Esq. ..	6 Slides of Podura Scales.
" W. Ladd, Esq.	1 Slide of Spiral Sulphate of Copper.
" F. R. Martin, Esq. ..	24 Slides of various Salts.
" Dr. Braidwood	12 Slides of Animal Fibre in Vertebrata.
" Dr. A. R. Betts	12 Slides of Anatomical Injections.

Besides the donations of Dr. Bastian and Dr. Carpenter, as mentioned by the President.

The Society was informed in my anniversary address, delivered last year, that the Council had decided upon terminating the agreement for the publication of its proceedings and transactions in the 'Quarterly Journal of Microscopical Science.' In conformity with this intention the connection of the Society with that journal ceased with the publication of the last October number.

In devising fresh plans, the following points had to be considered:

1st. Whether the proceedings and transactions of the Society should be issued by themselves, or in connection with similar matter derived from other sources.

2nd. Whether the publication should be monthly instead of quarterly, as heretofore.

3rd. If the Society should hand over its papers and proceedings for publication in a journal that was not entirely its own property, in what way its legitimate influence and control might be preserved.

4th. The best means of obtaining for the Society some advantage proportionate to the value of the matter it might place at the disposal of a publisher, and for its action and influence in securing and promoting the sale of any publication with which it might be connected.

After much deliberation it was considered that the interest of the Society would be best promoted by connecting the publication of its own transactions and proceedings with a record of the principal microscopical researches laid before other societies, or embodied in works not generally accessible. It was also thought desirable that the publication should be monthly, as ensuring the speedy communication to the scientific world of new facts and discoveries contained in papers read before the Society.

Your President and some members of the Council would have preferred that the Society should issue its own proceedings and transactions in a handsome form, and without the addition of any other matter; but they did not see their way to dissociate themselves entirely from all arrangements that had been made by their predecessors, and which had been many years in force.

For a long time the Fellows had been accustomed to receive in connection with their own proceedings, microscopical information drawn from various sources, and inquiries led your Council to believe that any changes involving a diminution of information would be repugnant to the wishes of the majority of the Fellows. They therefore endeavoured to make arrangements by which the Society would be a clear gainer, in the quantity as well as in the quality of the matter supplied.

There was another reason which influ[illegible] [illegible]m in this decision, and that was a desire to establish usef[illegible] [illegible] relations with other excellent Microscopical Societies [illegible] [illegible]tropolis and

scattered throughout the country. The mass of matter brought before all these bodies would preclude the possibility of combining it all in one publication of reasonable dimensions, but some record might be given of the most interesting facts contained in their papers, and a journal sanctioned by the Society and thus bringing to a focus information that had hitherto been so scattered as to be practically beyond the reach of most students, would render important service to the scientific world.

In reference to the third point of inquiry, it was deemed essential that the Society should have a copyright in an important portion of the title of any publication in which its transactions, &c., might appear, and that the proprietors of the journal in which they were published should only be at liberty to use such portion of the title so long as an agreement to that effect between him and the Society might subsist, and that the Society should have a voice in the appointment of an editor, whose duty it would be to place himself in intimate communication with it and to promote its interests.

It was thought proper that the proprietors of the 'Quarterly Journal of Microscopical Science' should have ample opportunity for making any offer to the Society complying with the preceding requisitions, but as they positively declined, attention was turned in other directions, and an arrangement was made with Mr. Robert Hardwicke, in conformity with all the Society's stipulations for the issue of the Monthly Journal, to commence on the 1st of January, 1869, to be edited by Professor Lawson, M.D., and to contain, in addition to the matter furnished by the Society, an ample digest of British and Foreign Histological Research and Microscopical Intelligence. Two monthly parts of the new publication have now been issued.

The cost to the Society for 450 copies of the new Journal will be £20 per month, and additional copies will be charged 1*s.* each. By this arrangement the Fellows will receive about twice as much matter in the course of each year as was supplied under the late arrangements, and they will have a monthly publication without materially adding to the expense heretofore incurred by the Society.

The first number made its appearance under considerable disadvantage, in point of the time allowed to the editor and publisher for getting it up, as circumstances prolonged the deliberations of the Council to within a few days of its issue. Your Council has pointed out to the editor what they deem necessary to give sufficient prominence to the Society's matter, and the editor has manifested every desire to meet their views.

I will now briefly pass in review the subjects that have been brought before us during the past year. In March, Dr. Murie read an elaborate paper on the "Classification and Arrangement of Microscopic Objects in Cabinets," a subject on which he could speak

with great practical knowledge. This paper will be found in the 'Monthly Microscopical Journal' for February, and deserves to be attentively studied by all who are engaged in the arrangement of collections.

On the same day Dr. Collingwood described a curious microscopic alga colouring the sea in various parts of the world, and especially in the China Sea. This curious plant gives the water "a dusty appearance," as though myriads of minute bodies were floating upon the surface and at various depths below. In some instances "a cream-coloured pellicle" would cover the sea for nearly the whole day with little interruption. These appearances were occasioned by minute bundles of vegetable filaments jointed like Confervæ. Dr. Collingwood describes some other floating bodies, but he did not encounter the "blood-red algæ," which seem to have been nowhere met with but in the Red Sea and in the Arabian Gulf, and only occasionally in those localities.

In April, Mr. Hogg read a paper, accompanied by many beautiful drawings of the Lingual Membranes of the Mollusca, and their value in classification. To Professor Loven, of Stockholm, we are indebted for the first attempts to make the lingual membranes a means of description. He proposed to divide them into fourteen groups, and separated the genera into families and sections characterized by the number, position, and forms of the teeth. This arrangement appears to have received the approval of Dr. Gray, Dr. Troschel, and others, who have sought to extend it and form it into a reliable basis for distinguishing species. The late Dr. J. C. Woodward appears not to have had much confidence in the systematic value of the lingual membrane, for he observes:—"It must be remembered that the teeth are essentially epithelial cells and, like other superficial organs, liable to be modified in accordance with the wants and habits of the creatures." This is true to a certain extent, but if, as Dr. Macdonald remarks, it is intended by the assertion that the teeth are essentially epithelial cells, to lessen their morphological importance and convey the idea of mutability, surely we ought to be able to draw a distinction between the normal and abnormal development of the same organs in different members of the same species. Moreover, the teeth are formed from a special matrix at the fundus of the lingual sac, determining in every case the constant evolution of certain characters; any defect in the formative pulp will repeat any consequent formation in each succeeding row of teeth. Notwithstanding the remarks just cited, Dr. Woodward must have seen some value in the lingual classification, for he proceeded to arrange his cabinet of so-called "palates" upon this system, and it was Mr. Hogg's good fortune to be able to draw upon this collection for the valuable and beautifully executed series of plates which adorn the pages of our transactions.

In May Mr. Roberts and Mr. Slack called our attention to the growth of fungoid threads in dialysed solutions of pure silica and their artificial fossilization as the silica solidified. Fungoid bodies appear to be capable of growing in a variety of chemical solutions, which might have been expected to prove fatal to vegetable life, even of the humblest kind; and this free growth in solutions of pure silica in distilled water suggests many curious questions of the relations in which that mineral stands to organic life. Even in solutions which are reckoned chemically pure, we may expect the presence of minute bodies floating in the air, and almost universally diffused. They may have afforded pabulum to the fungoid plants; but it would still appear from the experiments that were detailed that silica, in its soluble colloid state, does minister to vegetable life in some way not yet explained.

[The President then called attention to the leading facts in Dr. Thudichum's paper, given in our first number; to Dr. Maddox's paper on "Fungiform Papillæ," also in that number; and observed respecting the latter:—]

The general bearing of the paper appears to me to be a confirmation of the investigations on the Hyla by Dr. Beale; and his views on the distribution of the nervous system are decidedly borne out by Dr. Maddox in his examination on the common frog as to the termination of the nerves, whether distributed upon the surface of the sarcolemma, or whether passing through this coat. Dr. Maddox quite agrees in this particular with Dr. Beale, and the nerves figured do not appear to him to penetrate the sheath of the muscular bundles.

In November, Mr. Gorham brought under our notice new views on the composite structure of simple leaves, illustrated by a remarkably beautiful series of tracings, or nature-printings, obtained by blackening the leaves with the fine lamp-black obtained from burning camphor mixed with a minute portion of oil; then laying them upon white paper, and gently rubbing them to ensure contact. By this means the venation is accurately displayed in a very perfect and artistic manner.

[The President then gave an able abstract of Mr. Gorham's views, which may be here omitted, as the paper is printed in this number. He observed that although Mr. Gorham's researches were not in themselves microscopic, they could only be tested and worked out by microscopical investigations; and he referred to the views of M. C. De Candolle in the following words:—]

M. Casimir De Candolle has recently represented the leaf as a branch in a state of arrested development in certain directions. His observations and figures will be found in the '*Archives des Sciences*' for May, 1868, and in the 'Student' for August. M. De Candolle's descriptions and figures will greatly assist microscopists who propose

to enter upon this interesting branch of vegetable morphology. He observes, for example, concerning certain leaves of the Piperaceæ, that their internal structure appears to represent a branch with its posterior half atrophied; and he tells us that he determines the course of the ligneous bundles in each leaf by making numerous sections in all directions, and examining them with a pretty strong power.

At the November meeting of the Society, Mr. Kent exhibited living specimens of *Mysis vulgaris*, captured in the Victoria Docks. Drawing attention to the constant motion of the outer divisions of the thoracic limbs, he considered it highly probable that they served for respiratory purposes, in which case the recognized affinity of the genus with the Branchiopoda would be still further substantiated. Professor Sars has, however, recently demonstrated that a species confined to the fresh-water lakes of Norway possesses a peculiar series of reservoirs situated on each side of the thorax, wherein the blood is for a time detained before re-entering the heart, and there reoxygenized by the constant current of water passing between the carapace and the walls of the body, which current is produced by the movement of the outer divisions of the thoracic limbs observed by Mr. Kent, in conjunction with that of the epipodite of the first pair of maxillipedes.

Prof. Sars adds that he has by no means made out this system of reservoirs so clearly in the other species which he has examined —a circumstance which will account for its having hitherto escaped the observation of naturalists.

In December, Dr. Carpenter favoured us with a lecture descriptive of his deep-sea dredging expedition, which resulted in important discoveries, confirming the views which Dr. Wallich expressed many years ago, and opening the way to new theories and fresh investigations. The deep-sea life discovered by Dr. Wallich was quite sufficient to show that enormous pressure and the diminution of actinic rays at great depths did not involve the extinction of all life, as many eminent naturalists had supposed, or even the suppression of forms as high as the starfishes. Dr. Carpenter's dredgings prove that temperature, and not pressure, or other incidents of depth, is the chief determining cause whether life shall flourish or fail. When the influence of the Gulf Stream raises the temperature of the sea-bed currents, life corresponding to the amount of heat appears to be developed; and if at the same level the warm stream ceases and cold ensues, living forms become infrequent or disappear. The bearing of these researches upon various branches of science is highly important. The opinions held by many physiologists, that the sea had one uniform temperature at a certain depth is proved to be incorrect; life processes, not only of the lowest animals, but of *radiata*, polyzoa, crustacea, and mollusca, appear to go on satisfac-

torily under a pressure of many atmospheres; and even bright colours are developed in the absence of any appreciable quantity of light.

In what way inorganic matter in these deep-sea regions is brought within the life circle is not yet determined. Few naturalists now expect to find broad distinctions separating the animal and vegetable worlds; but the highest creatures living and growing in the sea depths must be dependent upon lower organisms, which, whatever work may be assigned to them, perform the functions of plants. The coccoliths and coccospheres, upon whose structure and character Dr. Wallich has thrown much light, appear to play an important part at great depths; but they are not confined to them, and Dr. Wallich states that they may be found abundantly off the west coast of Plymouth and other localities at about seventeen fathoms. Being thus available without much difficulty to many English microscopists, it is to be hoped that efforts will be made to study them in the living state and at various stages of their growth.

Professor Huxley has given the name of *Bathybius* to a protoplasmic matter found abundantly in deep-sea mud, and whether or not the theories he has associated with this substance may prove correct, its existence may help to illustrate the formation of the Eozoon; and Dr. Carpenter may, as he seems to anticipate, at some future time have the satisfaction of seeing that singular creature in a living as well as in a fossil form.

The chalk mud found extensively in the Atlantic sea bed shows, as Professor Wyville Thompson suggests, that we are still in what geologists term a cretaceous epoch; for near our shores chalk, with its characteristic mineral peculiarities and with its characteristic fossils, is still in process of formation from day to day.

Passing to another subject, I would simply allude to Dr. Bastian's paper on "Mounting and Tinting Animal Tissues," as affording very valuable information and suggesting more methods. Many anatomical structures, such as the brain and delicate nerve-tissues, can only be revealed to us when the microscope is assisted by such modes of preparation. The researches of Dr. Lionel Beale have made us familiar with this fact, and the experiments recorded by Dr. Bastian cannot fail to exercise a beneficial influence on future investigations.

Mr. McIntire read at our December meeting a paper on the "Scale-bearing Poduræ;" and as microscopists or entomologists have hitherto much neglected the study of these curious insects, his researches will be regarded as a useful contribution to a branch of knowledge in which our late esteemed colleague, Mr. Richard Beck, was engaged at the time of his lamented death, and concerning which he accumulated important facts, as well as leaving behind him many valuable drawings which he caused to be made.

Last year I made some observations on immersion lenses; and I am again induced to recommend that they should receive due attention, and that their capacities should be fully investigated. Mr. Mayall read before us a paper in which he commended those of Mr. Hartnack. I believe the only English makers who have made lenses of this description for sale are Messrs. Powell and Lealand, and I learn from Mr. Lobb that they work advantageously on difficult lined objects, but he does not give them a preference for ordinary research. A valuable paper, accompanied with photographs of Nobert's test-lines referring to these and other lenses, was communicated to the Society by Assistant-Surgeon and Brevet Lieut.-Colonel Woodward, of the United States army. This paper was printed in the 'Quarterly Journal of Microscopical Science' for October, without any acknowledgment of its having been sent for publication by this Society. Mr. Woodward states that out of the series of lenses at his disposal, including an $\frac{1}{8}$th of Ross, made two years ago, a $\frac{1}{16}$th of Tolles, made five years ago, an immersion system, No. 11, by Hartnack, made two years ago, an $\frac{1}{8}$th, an immersion $\frac{1}{10}$th, and a $\frac{1}{15}$th, by Wales, &c., he obtained the best results with the $\frac{1}{25}$th and $\frac{1}{50}$th of Powell and Lealand. The low prices of these immersion lenses as made by Hartnack and Merz must be considered as well as any merits they may be found to possess; and our English opticians will have to pay more attention than they have hitherto done to the question of price.

I hope the immersion lenses will be fairly studied, not only upon difficult diatoms and Nobert's test-lines, but upon objects requiring penetration and other qualities which lined objects do not sufficiently test. It is well known that many of the most important discoveries have been made and are made with objectives of moderate and even small angles of aperture; and we shall go backwards instead of forwards if we forget this fact, and estimate our glasses too exclusively by the difficulty of the lines they can resolve.

In reference to this subject I will only add that Messrs. Powell and Lealand make their immersion lenses with removable fronts, so that they may be used when required upon the non-immersion plan.

During the past year no very striking instrumental novelties have been presented to our notice. Mr. Hall brought before us an achromatic condenser in a modified form, and with many appliances; and as this instrument was presented to us by Mr. Swift, our Fellows can examine it at their leisure. Mr. Lee called our attention to improvements made by M. Nachet in his binocular microscope, and Mr. Heisch exhibited his modifications of the same instrument, which, as you will remember, is capable of producing pseudoscopic as well as the stereoscopic effects; this is accomplished by a simple method of changing the direction of the rays so that when the

pseudomorphic effects are desired those which ordinarily belong to the right eye go to the left and *vice versâ*. I have already had the pleasure of announcing that Mr. Heisch has sent one of these microscopes as a present to the Society, so that the Fellows will have the opportunity of examining this instrument at their leisure.

Mr. Beck has lately exhibited a new rotating stage, applied to his first-class microscopes, in which the chief peculiarity consists in the facility with which the pinion by which the slow motion is effected can be thrown out of gear, and a quick hand-motion permitted in its stead.

Some time ago Mr. Collins exhibited with his lamp a metallic chimney devised by Mr. Fiddian. This chimney had a white lining, and only allowed the light to escape in one direction, through a round hole covered with glass. Mr. Fiddian has since adapted this chimney to a very elaborate lamp constructed by Mr. Ross.

In the year 1867 I brought before you the very pleasing fact that Mr. Leaf, of Old Change, had founded a Microscopic Society, under the title of the "Old Change Microscopical Society." Since then this Society has steadily pursued its good work, and it is impossible to say how much good will accrue to microscopical science through training so many intelligent young men, accustomed to business habits, to close observation of natural objects.

In the first year of my Presidency a Microscopical Society was founded, under the Presidency of Dr. Lankester, with the title of the "Quekett Club." This Society has progressed most satisfactorily, and is progressing to increasing usefulness, under the Presidency of Mr. Durham.

The growing importance of microscopic research and the increasing demands for microscopic investigations cause us to feel glad at any addition to the number of good microscopists, and great mutual benefit must follow from the harmonious working together of the Fellows of this Society with the Members of the Quekett Club and those of the Old Change and other societies; and I look forward to a closer relationship between the members of these several societies.

At the last year's anniversary our numerical strength was 452. During the year the number of elections have been 21. We have lost 7 by death, 7 by resignation, and 7 expelled. Our present numbers are therefore 452; of these 93 are compounders. Thus the Society is flourishing; but its annual income is too near to the necessary annual expenditure, and all disbursements will require a careful consideration of the Council, so that our prosperity may continue.

In conclusion, it is now my duty shortly to resign this chair in favour of a gentleman well acquainted with the mechanical and optical powers of the microscope, and so well known in the world of

science, as to need no eulogy from me. The Rev. J. B. Reade, F.R.S., is one of the founders of this Society; he has watched its progress throughout, and having known him for many years, I cannot but feel that he is well fitted to fill the President's chair, and that he will in every way do it honour.

And now, gentlemen, my work as President has at length come to a close. In this chair, owing to your habitual kindness and forbearance, I have passed many pleasant hours.

In the chair of the Council I have also passed many pleasant hours, but some of them have also been very anxious.

The frequent meetings of Committee this year, particularly in relation to the publication of the transactions, has exacted from your officers a very great deal of time and attention, and my warmest thanks are due to all the members of the Council, and particularly to both the Secretaries; to Mr. Slack for his unceasing labours for the Society, and to Mr. Hogg for his untiring assistance; to them both I feel deeply indebted, and beg to tender my warmest thanks.

During my four years of close relationship with you, it has been a source of gratification to see the numbers attending our meetings more than doubled, the number of our Fellows greatly increased, the Society placed in a higher position, and its prosperity generally increased.

Accept my hearty thanks, and although my duties as President cease, I trust the good fellowship established between us will continue, and that I may be still useful in promoting the prosperity and increased usefulness of the Society.

II.—*On the Composite Structure of Simple Leaves.*
By John Gorham, M.R.C.S.

(*Read before the* Royal Microscopical Society, *November* 11, 1868.)

(Communicated by Jabez Hogg, Hon. Sec. R.M.S.)

Plate. V.

The results of my researches on the Leaf Structure are so at variance with those of the botanists, that I have hesitated in giving them publicity. They have stood in abeyance therefore for months. Every fresh observation, however, only tends to confirm me in their correctness. Under this impression I have at length ventured to ventilate them, and am glad to be able to do so under the auspices of the Royal Microscopical Society of London.

If we take any *compound leaf*, say that of the common Horse-chestnut, and, detaching leaflet after leaflet until the stalk is denuded, examine each of them in succession, it will be found that in their form, but especially their venation, they are all alike. They vary, it is true, in their size and the angular divergence of their veins, but, for the most part, it will be seen that they are so nearly fac-similes of one another, that what is true of one is predicable of all the rest. Hence we may safely infer that *a compound leaf* is *a multiple of similar structures.*

If we now take a *supra-decompound* leaf, say that of *Common Hemlock* (*Conium maculatum*), and carefully examine every pinnule with a lens, it will be discovered that all the pinnules are exactly alike—that they are each of them provided with a midrib which has its own particular set of veins, and that they are in fact of the nature of little leaves, which may not inappropriately be called *typical leaflets*, inasmuch as, so far from resulting from divisions of an otherwise supposed entire leaf, they are in reality model forms, typical representatives of which, by repetition, the whole leaf is constructed.

This feature is of more importance than might at first sight be apparent. It not only enables us to acquaint ourselves with the internal organization of the whole of the leaf by examining an infinitesimal part—a single leaflet, for instance, in ordinary compound leaves, a single pinnule in supra-decompound, but it enters largely and conspicuously into the composition of simple leaves, in one section of which the structures are not only repeated, but, as will be shown, apparently joined at their edges, so that what has hitherto been considered as a simple leaf merely, is really composed of a series of similar typical leaflets, which, by coalescence at their

sides and anastomosis of their vessels, have thus assumed a composite character, and formed a lobed leaf of one single blade.

It is by the recognition of this principle of repetition of similar structure, which is very palpable when once noticed, that the course of the veins in lobed leaves can be interpreted; for when once examined from this aspect, their ramifications from their origin to their final distribution can to a very considerable extent be predicted; and the reason why a vein should travel in one direction rather than in another, as if by a process of selection, becomes intelligible.

Leaves are divided into *simple* and *compound*. A simple leaf has one blade on one stalk; a compound several on one stalk, when they are called leaflets.

It is proposed in this paper to show that, of the four or five kinds of simple entire leaves which are distinguished by their venation, and classified in botanical works, there are two which are of more frequent occurrence than all the rest, and which for reasons to be specified demand especial attention. These are the *true Netted* Leaf and the *Feather-veined* Leaf. These two leaves should be well and attentively considered, and every vein in them thoroughly made out; because, while they are sufficiently interesting in their entire state—in which state, and as isolated from the rest, they have usually been treated of in the works on Botany—yet that they become especially so when studied in their relation to other leaves, entering, as they will be shown to do, into a multiplicity of combinations in which they may be distinctly recognized; thus affording evidence of the elementary forms out of which by their repetition thousands of other leaves are constructed.

It is then proposed to consider how these two simple leaves enter into the composition of almost all *compound*, *metamorphosed*, and *simple lobed leaves*. That when they do so they are arranged upon a petiole or leaf-stalk in one of two ways: first, *in a ray on the summit of the stalk* (radiating, palmate); secondly, *in rows on the sides of an elongated axis* (pinnate, feather-veined). That when the leaflets are thus arranged in compound leaves, they are always separate, not united at their edges; that there is a series of compound leaves, however, in which two or more of the leaflets are apparently joined at their edges: these are called *metamorphosed* leaves. Such leaves are important, showing, as they do, the possibility of union of the leaflets, and also the modification in the venation which takes place in those parts where the union is effected. That there is still another series called *lobed leaves*, in which the union of all the leaflets can be shown to have taken place, giving rise to forms which are precisely similar to compound leaves in the character of their leaflets, and to metamorphosed leaves in their mode of union. These are called *simple lobed leaves*, and

which are dissimilar to compound leaves only in the fact that all the leaflets have contracted union at their edges to a greater or less extent from their origin at the petiole towards their margin.

Metamorphosed leaves may be considered therefore as a series intermediate between the true compound and the true simple lobed leaf—a series which forms the connecting-link between the two; for a *metamorphosed leaf has its leaflets separate in one part, thus resembling a compound leaf; and its leaflets joined in another part, thus resembling a lobed one.* Viewed in this light, a lobed leaf may be assumed therefore not as having been divided into a determinate number of segments or lobes, designated by the terms *fissus, partitus,* &c., but rather as a multiple of two or more leaflets which have coalesced into one, and which would be more correctly described as *double, treble, quadruple,* &c., according to the number of leaflets which enter into its composition. The leaf of the *Sycamore*, for instance, is composed (according to this hypothesis) of five leaflets joined into one; and a knowledge of its true structure and minute venation is better conveyed to the mind by calling it a *quintuple* leaf, the typical leaflets of which are feather-veined and joined at their edges, than by using the adjective *quinquefid*, which gives, it is true, a notion of its five radiating ribs, with their respective lobes, but conveys no further information whatever as to the rest of the veins from which in great measure it derives its character and individuality.

Simple Entire Leaf.—Simple leaves are classified according to their venation; and are divided into the *netted*, the *feather-veined*, the *ribbed*, and the *falsely-ribbed*. These will be found described in botanical works. It is to the two first, however, that our attention will be especially directed, because of the frequency of their occurrence in their isolated state, and because of their constant repetition in composition.

The *true netted* leaf is thus described by Lindley:—"The *costa* (midrib) sends forth, alternately right and left, along its whole length, ramifications of less dimensions than itself. These I would call *Venæ primariæ*. They diverge from the costa at various angles, and, passing towards the margin of the leaf, curve towards the apex in their course, and finally, at some distance within the margin, form what is called an *anastomosis*—a junction with the bark of the *Vena primaria* which lies next them. That part of the *Vena primaria* which is between the anastomoses thus described, having a curved direction, may be called the *Vena arcuata*. Between this latter and the margin, other veins proceeding from the *Venæ arcuatæ* occasionally intervene: they may be distinguished by the name of *Venæ externæ*. The margin itself and these last are connected by a fine net-work of minute veins, which I would distinguish by the name of *Venulæ marginales*. From the costa are generally pro-

duced, at right angles with it, and alternate with the *Venæ primariæ*, smaller veins, which may be considered imperfect *Venæ primariæ*, and may not improperly be named *Venæ costales*. The *Venæ primariæ* are themselves connected by fine veins, which anastomose in the area between them. These veins, where they immediately leave the *Venæ primariæ*, I call *Venulæ propriæ;* and where they anastomose, *Venulæ communes*."

The *feather-veined* leaf is thus described by the same author:—"When the *Venæ primariæ* of a reticulated leaf pass in a right line from the midrib to the margin"—as in *Castanea* (Sweet chestnut) or *Corylus avellana* (Hazel). Plate V.

We have now to consider how, amongst the diversified and complex forms assumed by leaves, one and the same typical leaf structure, arranged in a variety of ways, is clearly discoverable in them all. This typical form may be either the *netted* or the *feather-veined* leaf. Let us take the latter, by way of illustration, and trace it through the seven series of leaves in which we think its presence is capable of proof, by a direct appeal to the leaves themselves.

1. The *feather-veined* leaf exists in its simple, entire, isolated state, as in the *Spanish chestnut* (*Castanea*), or the *Hazel* (*Corylus avellana*). Plate V.

2. It is repeated in the form of separate leaflets, which radiate from the summit of the petiole (leaf-stalk), as in *Horse-chestnut* (*Æsculus hippocastanum*). Plate V.

3. It is repeated in the form of leaflets which radiate from the summit of the stalk, and of which some are *separate*, others *united*, as in *Blackberry* (*Rubus fruticosus*). Plate V.

4. It is repeated in the form of leaflets which radiate from the summit of the petiole, and which are *all united at their edges*, half-way towards their margin, as in *Sycamore* (*Acer Pseudo-platanus*). Plate V.

5. It is repeated in the form of *separate* leaflets, arranged in rows on the sides of an elongated petiole, as in *Sumach* (*Rhus typhina*). Plate V.

6. It is repeated in the form of leaflets, arranged in a row on either side of an elongated petiole, some of which are *separate*, others *united*, as in the metamorphosed leaves of *Raspberry* (*Rubus Idæus*). Plate V.

7, and lastly. It is repeated in the form of leaflets, arranged in a row on either side of the petiole, and which are *all united* at their edges, to a greater or less extent, towards their margin, as in *Cineraria maritima*. Plate V.

When arranged in conformity with the usual nomenclature, this series resolves into—

1. The simple entire leaf, as it exists in its free, uncombined state.

2. The same leaf, as it is found in *compound leaves*.

3. The same leaf, as it is found in *simple lobed leaves*.

COMPOUND LEAVES.

α. Related to Simple Leaves.—A simple leaf arises by its stalk direct from the branch. A compound leaf is a simple leaf, or a multiple of them, attached to a stalk which arises from the branch. The leaves of a compound leaf are called leaflets: they are generally articulated (jointed) with the stalk. This is the idea of a true compound leaf. There are many leaves, however, in which the leaflets are not thus articulated, but which are still called compound. Even a single leaf, if articulated with its stalk, is, strictly speaking, compound: the leaf of the Orange is an example. The leaflets, in a compound leaf, are almost invariably *netted* or *feather-veined*. If we take a number of compound leaves, strip them of their leaflets, and sort them, they will be found divided into two groups, the one consisting of *netted*, the other of *feather-veined leaves*. The following are examples of compound leaves, the leaflets of which have a netted venation:—*Wisteria*, *Potato*, *Walnut*, *Ash*, *Virginian creeper*, *Tree of Heaven*, &c. Compound leaves with feather-veined leaflets are exemplified in *Horse-chestnut*, *Sumach*, *Hog-weed*, &c.

The association between compound and simple leaves is thus clearly established.

β. Related to Lobed Leaves.—The leaflets in compound leaves are arranged in two ways on their leaf-stalk—(1) in a ray diverging from the summit of the stalk, as in *Horse-chestnut*; (2) in a row on either side of an elongated petiole, as in *Ash*. *So are the leaflets in lobed leaves.*

The leaflets in compound leaves all expand in one plane. *So do those of lobed leaves.*

They vary in their dimensions, especially in their relative lengths, by which the outline of the entire leaf is determined. *So do the leaflets in a lobed leaf.*

They are arranged for the most part symmetrically on the sides of the stalk. *So are the leaflets in a lobed leaf.*

They are all separate, *not united* at their edges. It is here that the link between the two classes appears at first sight to be broken. This is more apparent, however, than real; for it can be shown that the two classes merge the one into the other by easy transition, and this through an interesting series of compound leaves which have suffered metamorphosis. For the leaflets in compound leaves are not always separate; they will be found to have contracted union at their edges in a group which has hitherto been considered insignificant, mere "lusus naturæ," or sports, and which have been treated in

N 2

botanical works as *irregular metamorphoses*. Such deviations from the normal structure, however, are not so irregular as might be supposed; they are, on the contrary, constant in certain genera and species, and are found as certainly on the same branch as the normal structure itself. If a compound metamorphosed leaf be carefully examined, it will be found that the change implied consists in the apparent union of two or more of the leaflets into one lobed leaf, the rest of the leaflets remaining free, separate, or uncombined, on the same leaf. A *quinate* leaf, for instance, shall present us with the curious anomaly of two of its lateral leaflets joined into one, thus converting the leaf into one perfect lobed leaf on one side, and three separate leaflets on the other. Plate V., D. Or, again, the two lateral leaflets on both sides shall have contracted union, forming a single compound leaf, consisting of two perfect bilobed leaves and a terminal separate leaflet. In another variety of the same species, a compound ternate leaf has all its leaflets joined into one trilobed leaf, and so on. I find analogous metamorphoses in *Jasminum officinale, Rubus Idæus, Rhus typhina, Sambucus nigra, Rosa canina, Phaseolus multiflorus, Pastinaca sativa, Dahlia, Lycospermum esculentum, Angelica sylvestris, Berberis fortunii, Clematis montana.*

What is worthy of especial note, however, is the exact resemblance in every minute particular borne by these united leaflets to the simple lobed leaf, whether in the normal venation in those parts of the leaflets which remain free, or in the modified venation where they have become united. In order more fully to exemplify this, let us revert to the leaf of the Blackberry, and examine a little more attentively the changes which have taken place in its venation in those leaflets which have coalesced into one from metamorphosis. The variety chosen is that which has five distinct separate feather-veined leaflets, radiating from the end of a common petiole, and constituting the true quinate compound leaf.

In its normal form all the leaflets are separate, and this is the type which prevails; but I have never yet examined a specimen without finding several exceptions,—one compound leaf shall have five leaflets, a second four, a third three, all on the same branch. A little closer inspection shows, however, that this variation in the number of the leaflets is apparent, not real, for in each leaf five leaflets can be traced distinctly enough, emanating as from a common source from the stalk, each having its particular outline and venation, only that two or more of them have become united at their edges, converting two leaflets into one, and so a *quinate* into a *quaternate* or *ternate* leaf. To leaves thus constituted, the adjectives *fissus, partitus*, can scarcely, I conceive, with propriety be applied. They owe their existence to the coalescence of two leaflets into one; and although they may be said to be *bilobed*, they cannot

be inferred to be *bi-fid*, but rather *duplex*. They are in reality double leaves, and it is on this hypothesis alone that their true structure can, I humbly submit, be interpreted.

If now we examine one of these double leaves, we find it presenting a normal and an abnormal venation—the one that of the separate leaflets on the rest of the leaf, the other that resulting from their junction. The normal venation shows itself on the outside of each rib, where it could not have suffered change from anastomosis; it peeps out also in the lobes, which are in reality the free projections of the several leaflets. But the course of the veins becomes disturbed and irregular in that region of the double leaf where the two leaflets appear to coalesce into one; this may be illustrated by a rough diagram (A, Plate V.), in which the double leaf, or, what I suppose to be synonymous, the bilobed simple leaf, is seen to consist of:—

EXPLANATION OF THE DIAGRAM, A, PLATE V.

1.—L C 'L, Intercostal space, bounded by the costæ (ribs), C L, C 'L.
2.—L A S, Lobular space, in which the vessels of the primitive leaflets are unaltered by anastomosis.
3.—C H L, Portion of leaf outside each costa, in which the veins are unaltered by anastomosis.
4.—C S, Commissural region, where the veins and veinlets from the two adjacent leaflets anastomose.
5.—Interlobular space, the depth of which is regulated by the breadth of the typical leaflets, and by the angular divergence of the costæ, L C 'L.
6.—L 'L, Apices of the lobes.
7.—S, Sinus between the lobes, where the coalescence between the two primitive leaflets ceases.
8.—L S, 'L S, Edges of primitive leaflets, which retain their original outline, marginal divisions, teeth, segments, &c., unaltered by coalescence.*

All this is in strict conformity with what can be demonstrated as true of the structure of the lobed leaf, and the foregoing example may be cited as an instance of the fewest elements of which it is possible for a lobed leaf to consist. For a lobed leaf must have at least two lobes; and if two lobes, two ribs; and if two ribs, two particular sets of veins; † and if two sets of veins, one similar to the other; and if both alike and joined into one, this is a double leaf, and, as I conceive, the simplest form of the lobed one. These features, one and all, are clearly discerned in the metamorphosis of the Bramble leaf, and will be found verified and repeated in any ordinary lobed leaf we may choose to examine for the purpose.

The relation between the compound and the lobed leaf is thus established.

* It is not to be understood that the leaflets overlap, or that the veins intersect; the diagram being designed merely for the purpose of defining the regions in which the veins *become altered* or *remain unaltered* by anastomosis.

† "In lobed leaves, which may be considered as simple leaves approaching composition, each rib has its own particular set of veins."—LINDLEY, 'Introd. Bot.'

It may be well to notice a little more particularly in this place the changes which take place in the *size*, *number*, and *distribution* of the veins in these regions (C S, diagram A), where the junction of the leaflets is effected; for whether in metamorphosed or in lobed leaves, the plan will be found identically the same. We notice, then, that the primary veins in some instances become very small, often increased in number, and that, after travelling in their accustomed course to about the middle of the region, they anastomose either directly or irregularly with those from the opposite side. In other cases they will be found nearly entirely obliterated to the naked eye, so that this portion of the leaf presents a smooth appearance, and leathery texture, nearly destitute of veins, and altogether different from the rest of the leaf. They vary, too, as the normal leaflet is *netted* or *feather-veined;* and, what is particularly worthy of notice, if the ribs diverge at a large angle, more of the normal venation is left in this region, clearly showing that it is to the junction of the vessels that the altered appearance is to be attributed. This is exemplified also, more or less, in all lobed leaves. It becomes difficult, therefore, to assign a cause for such a remarkable anomaly recurring regularly and alternately throughout their area, if it cannot be referred to this modification which takes place in the veins from the junction of adjacent leaflets.

From this aspect, the metamorphosed leaf becomes an interesting study to the botanist. It is not that insignificant sport of Nature which is to be disregarded. A friend of mine, on having such a leaf shown her, exclaimed, "Don't show me that deformed thing; it has grown against a wrong wall, and is all lop-sided." Yet that very leaf contained, as I believe, the key which was capable of deciphering the structure of the lobed leaf.

It is far from my wish to assign an undue prominency to these metamorphosed leaves; yet the more attentively they are examined, the more clearly will it appear that they are related, on the one hand, in their separate leaflets, to compound leaves, and, on the other, in their united leaflets, to lobed ones. They furnish us, therefore, with a transitional series, forming the bond of union between two classes which have hitherto been separated by a pretty wide line of demarcation, but which, nevertheless, are thus shown to be related by natural affinity.

It was intended to illustrate this portion of the paper by a series of figures from impressions taken direct from the leaves themselves, and prepared expressly for the purpose. As their publication, however, would have involved much time and labour, I have restricted myself to a few selected from the series, and which, from being of rare occurrence, or fine specimens of those which are more common, will be found sufficient to illustrate what is intended. They are all of them examples of the union of two leaves into one,

as well as of the anastomosis in those parts where the junction is effected.

Rubus fruticosus (Blackberry) shows the junction, into one, of two of the lateral leaflets of an otherwise true quinate leaf. The change in the direction, size, and number of the primary veins in the sutural region is well marked. This metamorphosis is very common. Plate V., D.

In *Rosa canina* (Diagram B, Plate V.) I have occasionally found the terminal leaflet assuming the form and character of two netted leaves united into one, forming a true *bilobed* leaf.

The same kind of change, but still less common, occurs in *Phaseolus multiflorus* (Scarlet-runner), from the smaller divergence of the costæ of which, less room is left for the development of the normal venation in the anastomosing space.

In *Rubus Idæus* (Raspberry) it is common to find the upper lateral leaflet joined to the terminal one. Plate V. The normal arrangement of the leaflets in this leaf is for each to be separate throughout its whole extent.

Of Lobed Leaves.

By a *lobed leaf* is to be understood a leaf which has one single blade, but which is partly divided into a determinate number of segments. We say *bilobus*, two-lobed, as in the leaf of *Bauhinia porrecta*; *trilobus*, three-lobed, as in the leaf of *Anemone hepatica*; *quinque-lobatus*, five-lobed, as in the leaf of Sycamore; and so on.

The recesses between the lobes are of various depths, and terms have been employed to distinguish them. When a leaf is divided nearly to the base, it is said to be split (*fissus*). We say *bifidus*, split in two; *trifidus*, split in three. When the segments are very numerous, *multifidus* is used. The word "parted" (*partitus*) has the same meaning.

Examples of the lobed leaf are found in *Sycamore, Hop, Vine, Ivy, Red currant, Maple*, &c.

Such is the construction usually put on this class of leaves—a single expansion of leafy matter, containing a homogeneous network of veins, traversed by a few larger ones, called ribs (costæ), and divided in a thousand ways at the margin, giving rise to important characters, by which they may be distinguished the one from the other.

The complicated forms assumed by lobed leaves, together with the intricate, and often indefinite, course taken by their veins, have always proved to me a source of perplexity; and I have repeatedly attempted to find a clue to their interpretation, so that their outline might be reduced to some definite plan, on the one hand, and the ramification of their veins unravelled in conformity with some fixed design, on the other. These two difficult botanical problems would

appear to me to be at length capable of solution. In order to show this, however, it will become necessary to dispense with certain preconceived notions as to the structure of the lobed leaf: to consider it no longer as a single blade, from the margin of which certain portions of determinate outline have been cut or excised, and through the substance of which the veins proceed in a deviating, often undetermined course; but rather as a structure consisting of many similar parts, *quasi leaves*, the number of which is indicated by that of the lobes, and the junction of which has converted what would otherwise have been a compound, into a simple lobed leaf. That such union of the leaflets is actually effected, has been partially discussed; but we think it can be proved, almost to demonstration, by cumulative evidence from a variety of sources, viz.—(1) *by direct appeal to the leaf itself;* (2) *by synthesis;* (3) *by analysis;* (4) *by metamorphosis;* (5) *by analogy.*

(1). Let us take any well-defined lobed leaf—say that of Sycamore—and map it out into regions, which are suggested by a careful inspection of its integral parts.

EXPLANATION OF THE DIAGRAM, C, PLATE V.

L C 'L, Intercostal space, or space bounded by two adjacent costæ, and containing:—

S C, Commissural space, in which the vessels from two adjacent leaflets anastomose.

L A S, Lobular space, in which the vessels of the typical leaflets are not altered by anastomosis.

C H M, Lobular space on outer half of the lowest costæ, C M, in which the vessels of the typical leaflet are unaltered by anastomosis.

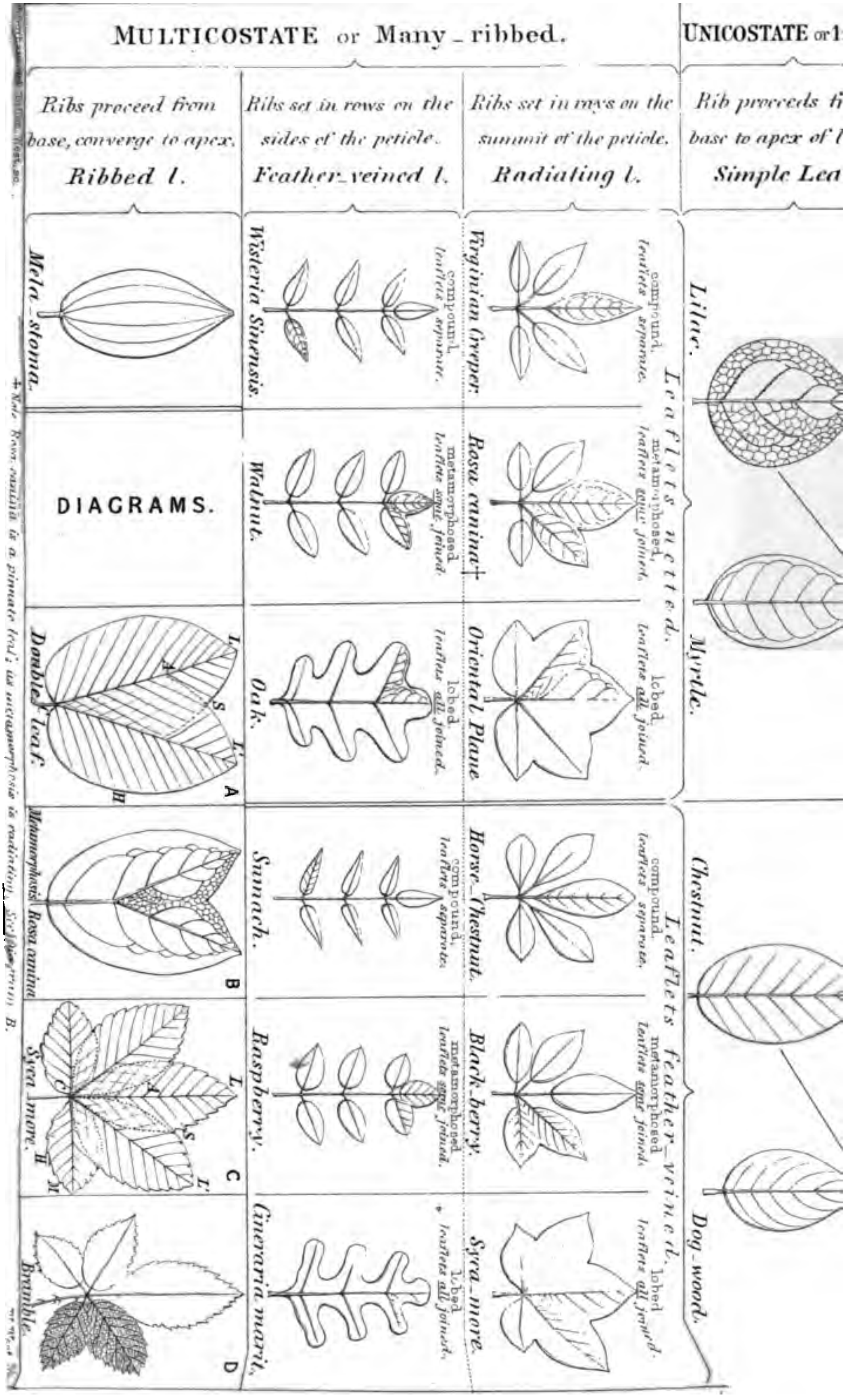
L S 'L, Interlobular space, broad and deep, or narrow and shallow, varying with the angle of the costæ (L C 'L) and the breadth or expansion of the typical leaflet, L S C.

L, Apex of lobe.

S, Sinus between two lobes; the part where the lobes commence, or where the coalescence of two typical leaflets ceases.

L S, and C H M, Edges of typical leaflets, which retain their primitive outline unaltered by coalescence.

According to this showing, it would appear that the leaf in question is composed of five distinct *feather-veined* leaflets; that these leaflets are all united in those regions indicated by actual inspection of the leaf, and defined (C S) in the diagram; that the venation in each of the leaflets is nearly that of a perfect feather-veined leaf, and that its normal type is clearly visible in those parts, L A S and C H M, where the vessels could not by possibility anastomose; but that the venation becomes mixed—abnormal—in those regions, C S, where the vessels must meet, and where anastomosis is inevitable. It is evident also that the free projections of leaf texture beyond the sinus S, and called lobes, are really the terminations of the leaflets themselves, being veined, and notched or toothed at their margins like ordinary leaves; again, that the recesses between these lobes are



MULTICOSTATE or Many-ribbed.
UNICOSTATE or 1
Ribs proceed from base, converge to apex.
Ribbed l.
Ribs set in rows on the sides of the petiole.
Feather-veined l.
Ribs set in rays on the summit of the petiole.
Radiating l.
Rib proceeds fr
base to apex of l
Simple Lea
Mela-stoma.
DIAGRAMS.
Double leaf.
Metamorphosed Rosa canina
Syca-more.
Bramble.
A
B
C
D
Wisteria Sinensis.
compound, leaflets separate.
Walnut.
metamorphosed leaflets semi-joined.
Oak.
lobed leaflets all joined.
Sumach.
compound, leaflets separate.
Raspberry.
metamorphosed leaflets semi-joined.
Cineraria marit.
Virginian Creeper.
compound, leaflets separate.
Rosa canina†
metamorphosed, leaflets semi-joined.
Oriental Plane
lobed leaflets all joined.
Horse-Chestnut.
compound, leaflets separate.
Black-berry.
metamorphosed leaflets semi-joined.
Syca-more.
lobed leaflets all joined.
Leaflets netted.
Leaflets feather-veined.
Lilac.
Myrtle.
Chestnut.
Dog-wood.
† Note. Rosa canina is a pinnate leaf; its metamorphosis is radiating

the necessary result of the perfect growth of the lobes themselves, or, in other words, the ends of the leaflets with which they are synonymous. Hence that these spaces do not denote imperfect nutrition and development of parts of the leaf; neither can they be considered in any way as divisions taking place in a leaf otherwise entire, but rather as the void spaces left where the coalescence of two adjacent and perfect leaflets has ceased to exist. The boundaries being thus defined, the leaf is resolved into at least two important regions—the one containing an ordinary, the other an extraordinary venation. The structure of the entire leaf becomes thus perfectly intelligible. If the altered venation taking place in the commissural spaces is not due to anastomosis of the vessels from two adjacent leaflets, I would venture to ask on what other hypothesis can it be accounted for? If it be allowed to be the result of such anastomosis, it would appear to me that a solution is afforded to the intricate structure of the whole of the lobed leaf.

The leaves in the second and remaining division of lobed leaves are like the last in their leaflets and their mode of junction, and differ only in having them arranged on the stalk like those in a pinnate leaf.

Among true lobed leaves the following may be cited as examples belonging to this second class:—*Quercus robur*, *Quercus ruber*, *Quercus lyrata*, *Hydrangea quercifolia*, *Carduus crispus*, *Centaurea candidissima*, *Cynara scolymus*, &c.

From a series of interesting metamorphoses I have selected two as typical of the rest, and which show the transition from the true *pinnate* to the true *penni-veined lobed* leaf. These are *Rubus Idæus* (Raspberry), and *Juglans regia* (Walnut).

(2). The structure of the lobed leaf may be inferred from *Synthesis*, *i. e.* taking the leaflets of a compound leaf, and assuming them to have become joined at their edges, when a true lobed leaf would result. That this is not a mere fanciful theory in support of a favourite hypothesis, is shown from the fact that the leaflets do thus become actually joined in compound leaves. On referring to the leaves of the Blackberry, it will be seen that such leaves may be considered with equal propriety either as imperfectly formed compound leaves, or imperfectly formed lobed ones. If all their leaflets were separate, the leaf would be *true compound*,—if all joined, *true lobed*. That, when the leaflets are thus united, their composite structure becomes identical in character with that of an analogous portion marked out in a lobed leaf, there can be no doubt. On this head the following may perhaps be considered conclusive—a kind of *experimentum crucis* from which there can scarcely be any appeal. Take the lobed leaf of Sycamore, and the united leaflets of the compound leaf of Blackberry (Diagram D, Plate V.), and place them side by side in order to compare them. If, now, it be allowed

that the leaflets in the latter have contracted union at their edges, it is difficult, if not impossible, to deny this kind of change to the analogous portion of the leaf of the former. The plan of the two seems identical.

(3). By *analysis;* that is, by assuming the lobed leaf itself to have been disintegrated in those parts where the natural seam or suture shows itself, and comparing the detached portions with the leaflets of a compound leaf. That lobed leaves will bear this test, is best shown by trying the experiment. In those cases where the leaflets have coalesced a short distance only from their origin (the deeply parted leaves of the botanists), the leaflets may be detached almost entire, and resemble all but perfect leaves. Witness, for example, the leaf of *Passion-flower*, or of the *Oriental Plane-tree*, amongst the radiating, or the leaf of the *Artichoke* (*Cynara scolymus*) amongst the pinnate varieties. In other instances, where the recesses are less deep, the leaflets can still be detached, leaving a sufficient portion of the normal venation to mark their identity. Take the *Oak leaf;* here the recesses are shallow, yet a number of elliptical netted leaflets can be excised from either side of its midrib ? (petiole) without difficulty. In some, again, the process of disintegration is more difficult, as in *Tropæolum majus* (Garden Nasturtium), where the primary vein first given off from one of two adjacent leaflets, is reciprocally common to the integrity of them both.

(4). *By analogy.* All analogy may be said to be in favour of our hypothesis. By common consent, the whole of the plant—bract, calyx, petal, stamen, pistil—is now considered to consist of modified leaves. The truth of this theory is universally adopted by all philosophical botanists. If, now, in order to bring the structure of the leaf into conformity with the theory, that by its modification it might become converted into an ovary, it was necessary to assume such leaf as curled round until its lateral margins met, and then united into a carpel; and if the structure of the ovary, based on such an hypothesis, is considered as much a fact as any other fact in botany, the theory of one leaf lying flat and in perfect apposition with another, and both then contracting union into one, can scarcely be held untenable. There is nothing in the analogy of the case to prevent such union; and it is as much within the range of probability that five leaflets may coalesce into one polyphyllous leaf (*lobed leaf*), as that an ovary may be composed of five syncarpous pistils.

Of Classification.

A classification based on the prevalence of some typical form pervading a whole series must needs be a desideratum. The table seen in Plate V. is constructed on this principle, and scarcely requires explanation, saving that all reticulated leaves are thus, for the most

part, brought into close relationship with the true *netted* and the *feather-veined* leaf.

From the foregoing paper the following inferences will, I trust, be considered as legitimate:—

1. That, while a leaf may be considered and described, with respect to its vernation, internal structure, figure, articulation, insertion, margin, surface, venation, direction, colour, texture, and size, yet that the internal structure, so far as relates to its form, is to be found in the distribution of its veins.

2. That there is a certain uniformity and simplicity in the formation of a leaf, which is consonant with that pervading all vegetable structures.

3. That this manifests itself in the existence of an organism having all the semblance and parts of a real leaf, to which, for descriptive purposes, I have ventured to give the name of *typical leaflet*, and which, by constant repetition, forms in the aggregate the entire leaf.

4. That the leaflets in many compound leaves are essentially simple in their structure, not capable of being resolved into smaller ones. They constitute in themselves, therefore, the typical leaflets of which such compound leaves are composed.

5. That while the typical leaflet often exists in a free, uncombined state in compound leaves (in *Conium*), yet that sometimes a number of them are aggregated together into one leaflet (in *Heracleum; Pastinaca*).

6. That the venation in a typical leaflet is like the ordinary venation in the leaflets of compound leaves, *i. e. netted* or *feather-veined.*

7. That, whatever be the shape or size of the typical leaflet, its venation is always the same in the same leaf; and, therefore, to know this of one, is equivalent to knowing that of the whole leaf.

8. That, with respect to their form (and it is from this aspect alone that they are now being considered), compound leaves are the representatives or types of simple lobed leaves; and, but for the separation of their leaflets, would almost exactly resemble simple lobed leaves.

9. That if the leaflets in compound leaves were united at their edges, therefore, a simple lobed leaf would result.

10. That the union of two or more leaflets into one is seen to be possible, because it is actually effected in metamorphosed leaves.

11. That when the junction of leaflets takes place in metamorphosed leaves, it is accompanied by certain modifications in the size, number, and course of the veins, in that part where the union is effected; while the rest of the veins retain their normal size, number, and direction, unaltered by anastomosis.

12. That precisely the same modifications in venation are to be

found in lobed leaves—a normal venation belonging to the leaflets of which they are composed, and a mixed or irregular venation in those parts where they appear to be united by anastomosis.

13. That when a lobed leaf is examined for the purpose of tracing out its integral parts, it may be mapped out into boundaries, which contain—(1) structures like little leaves (typical leaflets); (2) the edges of such structures joined by the anastomosis of their vessels; and these structures, in their relative size, shape, venation, and symmetrical arrangement on the petiole, will be found to resemble the leaflets in compound leaves, only united at their edges.

14. That while the possibility of such junction of leaflets into one entire blade is inferred from metamorphosed leaves, it may also be presumed to be likely, from analogy with other vegetable structures (the union of the edges of a single leaf into a carpel, the coalescence of carpels into a pistil, the repetition of similar leaves on a branch, and of like branches on a tree), and from a careful inspection of lobed leaves themselves.

15. That the lobes themselves, in simple lobed leaves, are suggestive of their composite character.*

16. Assuming that lobed leaves are a multiple of typical leaflets, united at their edges into one leaf, it may be inferred :—

17. That the lobes themselves, in simple lobed leaves, are the projections of perfectly-formed typical leaflets, of which the entire leaf is composed; and that these projections are merely the parts of such leaflets which have not contracted adhesion to one another at their edges.

18. That the fissures or recesses between the lobes are the void spaces between the free margins of typical leaflets.

19. That the outline of the sides of the recesses is in conformity with that of the typical leaflets, while their depth and width is directly related to the angle of divergence of the costæ of the typical leaflets, and to the breadth of the leaflets themselves.

20. That these spaces are not really the result of splits, fissures, or divisions taking place in a leaf otherwise entire; and hence that the terms usually employed to designate such vacancies fail in conveying to the mind their true nature, by assuming the leaf to have been once entire, else how could it have suffered excision?

21. Hence that the notion of the existence of lobes and openings in a leaf, as produced by an imperfect union of parenchyma, and from a diminished extension of cellular tissue in the recesses, is untenable.†

* "Lobed leaves may be assumed as simple leaves approaching composition." —LINDLEY, 'Introd. Bot.,' p. 90.

† "But when the separation of the principal veins is greater, and the cellular tissue is comparatively less extended, the union of parenchyma takes place only in an imperfect manner, and thus lobes and openings are produced in the middle of the leaf, or various kinds of toothings in its circumference."—DE CANDOLLE, quoted by Lindley, 'Introd. Bot.,' p. 112.

22. That the notion of a leaf being imperfectly developed, because it is divided by deep recesses, is untenable.

23. That to suppose a leaf to be perfect only when it has all its parts filled in to the very margin by parenchyma, is to assume that all leaves should be thus developed conformably with some assumed geometric figure, which, if carried into effect, would reduce them, one and all, to a monotonous series of ellipses, ovates, or some other figure, which it may be fairly presumed to be difficult to describe.

24. That the form of a leaf is perfect as a leaf, and not as some geometric figure yet to be assigned to it. A Fennel leaf is perfect in form with nothing but its linear segments; so is that of Lilac, which has no segments at all.

25. That the projection in form of a leaf accords with that of its component leaflets. When these have ceased to grow, the leaf has arrived at its stage of maturity. It is then that it becomes stamped with its normal form, by which it is characterized from other leaves. Its character depends on that of all its parts; and it derives its beauty from their assemblage, without being like one of them. The human figure is bounded by a series of ellipses—the whole figure is not an ellipse.

26. That each typical leaflet contains within itself the distribution of every small vein and minute veinlet, to its ultimate destination in the parenchyma. To have become conversant, therefore, with the anatomy of this portion of a leaf, is to have become acquainted with the internal structure of the entire leaf, inasmuch as the whole is made up of similar parts.

27, and finally. The only legitimate limit which can be put on such a subdivision of an entire leaf is that when all trace of a real typical leaflet, to be discovered within its structure, ceases.

III.—*On the Construction of Object-glasses for the Microscope.** By F. H. Wenham.

(*Continued from page* 113, *No. II.*)

The aperture of this object-glass is 130°, which is amply sufficient for a good working $\frac{1}{8}$th. In the triple back, the three cemented or contact surfaces are of the same radius, as I have not been able to ascertain that any material effect in the correction for spherical errors can be obtained by a difference in the two radii of the concave flint, and therefore, for the sake of facilitating the workmanship, both faces are similar. I am aware, however, that some makers hold a different opinion, and make the incident-surface of the concave much deeper, and the other longer in due proportion. The front of the triple is flat; but as the perfection of an object-glass depends in a remarkable degree upon the radius of this surface, a plano-convex lens cannot always be applied as a rule, for the curvature depends very much upon the nature of the glass employed in the construction, and the distance at which the lenses are placed asunder.

The correction for oblique pencils, and flatness of field, are mainly effected by an alteration in this radius, ascertained from the appearances of a globule of mercury, hereafter to be explained. Also, for the convenience of working, the posterior and contact surfaces of the middle lens are of similar radii, and the required negative correction for colour is obtained by an alteration in the concave incident-surface of the flint. The back and middle lenses are worked as thin as possible. It is an easy matter to make convex lenses to a sharp edge; but to ensure the requisite thinness in the concaves, the edges are polished before the grinding is completed; and this is continued till they are seen to be as thin in the centre as may be deemed practicable, without the risk of breaking them through.

In the construction of the highest powers of the microscope, or such as are composed of three distinct sets of lenses, it must be borne in mind that the magnifying effect is obtained principally by the front lens; and the combined operation of the middle and posterior, is entirely corrective; and their application in any combination must always be so considered, and not as a means of obtaining

* In the last number of this Journal the dimensions of the front of the $\frac{1}{8}$th appear as hundredths instead of thousandths. The cipher should be before instead of the end of the decimal, thus—"diameter of lens ·093, thickness ·057." I had overlooked this in the proof.—F. H. W.

additional power. If the front of an $\frac{1}{8}$th or $\frac{1}{12}$th is tested alone, it will be found to magnify very nearly as much as when the other lenses are replaced.

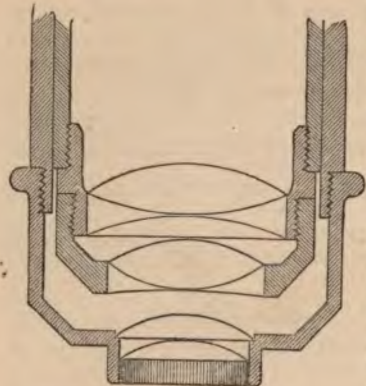
The single front has the advantages of facility of construction, and a command of any required extent of aperture; and enables object-glasses of higher power to be made than would otherwise be practicable. For example, the radius of the front lens of a $\frac{1}{50}$th is $\frac{1}{120}$th of an inch, and the diameter $\frac{1}{70}$th. The difficulty, if not impossibility, of constructing a *triple* of such almost invisible atoms of glass may be imagined.

In May, 1856, I made the first $\frac{1}{25}$th with a single front lens of $\frac{1}{30}$th in diameter; I am doubtful whether a triple front could be made even of this size, with any positive certainty of accurate workmanship.

From an $\frac{1}{8}$th and upwards, perfect correction may be secured with a single front. It is, however, barely possible to make a good $\frac{1}{5}$th with this form, and in a $\frac{1}{2}$-inch it fails altogether; there is a kind of secondary spectrum that cannot be got rid of. It is not easy to define all the reasons why it should succeed perfectly with the highest powers, and the correction be imperfect with the lower ones named. With smaller apertures the errors of spherical aberration cannot be so well corrected by giving thickness to the front lens; and as there is considerable distance between this and the middle, the coloured rays from the uncorrected front are so far separated, that any corrective action of the back systems is incapable of recombining them. When an object-glass is spherically under-corrected, the focus of the central rays is longer than that of the marginal ones, as in a single lens. If all the rays are brought to one point, the interposition of a plate of parallel glass projects the outside rays to a greater distance than the central ones, and produces a similar effect to a concave lens, or that of over-correction; and it is for this reason that a certain thickness of glass before, or in the substance of the front lens has such a remarkable corrective power, which is most appreciable with a very large aperture. Where this is comparatively small, as in a $\frac{1}{2}$-inch, the influence of a thick front does not appear to be sufficient to enable the final correction to be obtained by this means alone. The anterior lens must therefore either be partly achromatized, or made of a glass of higher refractive and less dispersive power than any at present known.

It is well known that, in a doublet consisting of two single plano-convex lenses, both the spherical and chromatic aberrations are considerably less than in a single lens of the same magnifying power. I have for this reason proposed to construct the higher powers with two single lenses in front, of equal radius, as shown by

the cut. The correcting thickness should be thrown in the first lens. If they are set in contact, the magnifying power will be nearly as their sum; they may therefore be made of double the radius, and consequently nearly twice the diameter, which, of course, would lessen the practical difficulty of working a $\frac{1}{50}$th, and enable us to go even beyond this power. A partial experiment with a $\frac{1}{4}$th, having this "doublet" front, has proved that perfect correction for colour is the result. But in the form tried, the spherical aberration was so considerable, as to require an entire reconstruction, for which I have now no leisure; and though the entire success of the idea is yet unproved, I venture to record it, in case I may never be able to take up this subject again, as I am of opinion that a very perfect object-glass may be made of this form.



Recently some excellent glasses have been made, as the so-termed "immersion lenses." These combinations are under-corrected, and not suitable for use in any other way. The plan is an old one, and objectives were constructed on this principle by Amici and Ross many years ago. That such lenses give brighter and clearer definition, with the highest powers, from the $\frac{1}{12}$th upwards, is unquestionable; but the effect of the water and covering-glass is precisely the same in its corrective action *as additional thickness thrown on to the front lens.* The interposition of water doubtless tends to neutralize errors of surface and polish, and more light is transmitted in consequence; but, as organic preparations are generally not so minute in their structure as to require the habitual employment of such object-glasses (which are useless without the water film), it will probably be found, that the inconvenience attached to their use will not compensate for their advantages. Allowing that they perform better on the *Diatoms* and other tests, it would be preferable to mount these objects, in which special discovery is required, without any covering-glass, and have an objective of $\frac{1}{50}$th constructed with a thick front, specially corrected for uncovered objects only. This having no adjustment, the best definition would always be a matter of certainty, which cannot be the case when the covering-glass, with its varying thickness and errors, forms part of the optical combination.

The late Richard Beck strongly advocated this mode of viewing *Diatoms*, and had a series of them mounted as uncovered objects,

in a peculiar way, so as to prevent injury from dust; but when the highest powers then in use were set to the line "uncovered," their apertures became so far diminished by this correction, that the advantages in defining difficult tests were not so apparent as if a glass had been made specially for viewing them in this state, or an extra front lens had been adapted to existing objectives for this particular investigation.

On the Observations requisite for Correcting Object-glasses.

For this purpose, a particle of mercury is placed upon a slip of black glass. A piece of watch-spring, or the thin handle of a spatula, is held up at its end by the fore-finger of the left hand, and slapped smartly down on the mercury, which is thus beaten into powder, in the form of numerous minute globules. Of these, a larger size is selected for correction for colour, and a minute one for ascertaining the errors of figure and centering, and state of the oblique pencils.

The globule must be illuminated by direct candle or lamp light, *and not by daylight*, as the latter will not allow perfect correction to be obtained. The light requires to be set as close as it can be, and, of course, in the highest powers, where there is little distance in front. It must be very oblique; but this is of no consequence, as it is not the globule itself, but the spot of light reflected from it, that is required to be seen.

(*To be continued.*)

IV.—*On a New Growing-slide.* By C. J. Muller.

Microscopical observers, whose attention has been bestowed upon animalcular life and cryptogamic aquatic vegetation, have long sought for some simple means of preserving the subject of investigation moist and in a state of vitality during prolonged examination under the microscope. The old fashioned polype-trough, the live-cage, the sunk-cell, were the earliest contrivances for this purpose. Recently, Professor Smith, of Kenyon College, Ohio, introduced to the notice of microscopists a growing-slide, described in the 'Annals of Natural History,' Nov. 1865, a modification of which was suggested by the late Mr. Richard Beck, in a paper read before the Microscopical Society of London, on Dec. 13, 1865; and still later, Dr. Barker, of Dublin, proposed a piece of apparatus, by which an object placed upon an ordinary glass-slide might be kept moist, with very little attention, for a considerable period.

To the American growing-slide, several serious objections have been advanced. First, that it is difficult to fabricate, except by experienced hands; 2ndly, that it is impossible to clean it, except by pulling it to pieces and recementing the parts; 3rdly, that the thickness of the cell interferes fatally with the use of various sorts of illumination below it, when objectives of high power are employed.

Mr. Beck's contrivance offers a partial remedy for the inconvenience last named, but does not wholly succeed, and moreover the supply of air and water is limited, besides which the apparatus is such as no amateur could make himself.

Dr. Barker's invention seems to me to be rather too elaborate and costly a contrivance for the purpose required. It is even more difficult of fabrication than the American apparatus; and it is evident that an observer would require at least half-a-dozen of these growing-stages to help him in his observations—one stage being good for only one slide at a time. This gentleman, in his paper on the subject in the 'Quarterly Journal of the Microscopical Society' for January, 1867, has admirably stated the qualities which a good growing-slide should possess; *viz.* 1. It should be efficient and not likely to go out of order, neither flooding the object and overflowing the stage, nor drying up and allowing the air to get under the cover. 2. It should be easily cleaned. 3. It should work well for at least a week, and even then should be capable of being supplied with fresh water without disturbing the object. 4. It should enable the investigator, when in ordinary microscopic examination with a common slide and cover he may have found something which he may wish to preserve moist and observe on a future occasion, to do so with facility. 5. It should allow of the object being examined at

any time without displacement. 6. It should permit the whole of the covering-glass to be examined, and it should not be in the way of any other piece of apparatus; and lastly, it should not be costly in price.

I find that all the conditions prescribed by Dr. Barker as essential qualities in a growing-slide, are met by the simple piece of apparatus which I will now describe.

Any ordinary glass-slide is pierced with a minute hole, at about three-tenths of an inch from the centre, on one side. When an object under investigation is put upon it immersed in water, the thin glass cover is so placed as to include this hole, which may be near the margin of the disk. When it is desired to keep the specimen moist while off the stage of the microscope, the slide is placed in the undermentioned piece of apparatus; *viz.* a flat trough 7 inches long, $2\frac{1}{2}$ inches wide, with straight sides $\frac{3}{4}$ of an inch high. In this the slide is placed, object uppermost, with one end (that nearest the hole) resting against the bottom of the vessel on one side, and the other end resting upon the edge of it. Sufficient water is put into the vessel to admit of the liquid reaching within a quarter or half an inch of the glass cover on the uppermost side, when it will be found that the water on the under-side reaches beyond the centre of the slide, and consequently beyond the hole with which it is pierced. In this state, the object will remain moist so long as the trough contains a sufficient quantity of water. When required to be placed on the stage of the microscope, the water is easily wiped off the slide without any disturbance of the object.

The trough may be made of tin plate japanned, or of glass, or of porcelain, and conveniently divided into six water-tight compartments, whereby any number of slides up to six may be immersed in water without one interfering with the other.

It is easy for the microscopist to provide himself with two or three dozen glass-slides, pierced as here described. If habitually used when examining aquatic objects, it will always be within his power to preserve in a moist state for an indefinite time any specimen he desires to look into further. By cementing a glass ring upon the slide, a cell of any depth may be employed.

There is yet much to observe in regard to aquatic vegetation and animalcular life, which can only possibly be done by having the power to keep the object in a vital state for a considerable period, and under conditions which admit of the use of the highest powers of the microscope. A good growing-slide is therefore one of the most important pieces of apparatus which the microscopist can possess; and I shall be glad if the contrivance here submitted meet this want, and serve as a stimulus to increased observation of cell-life in aquatic organisms.

V.—*On Triarthra longiseta.* By C. T. Hudson, LL.D.

Plate VI.

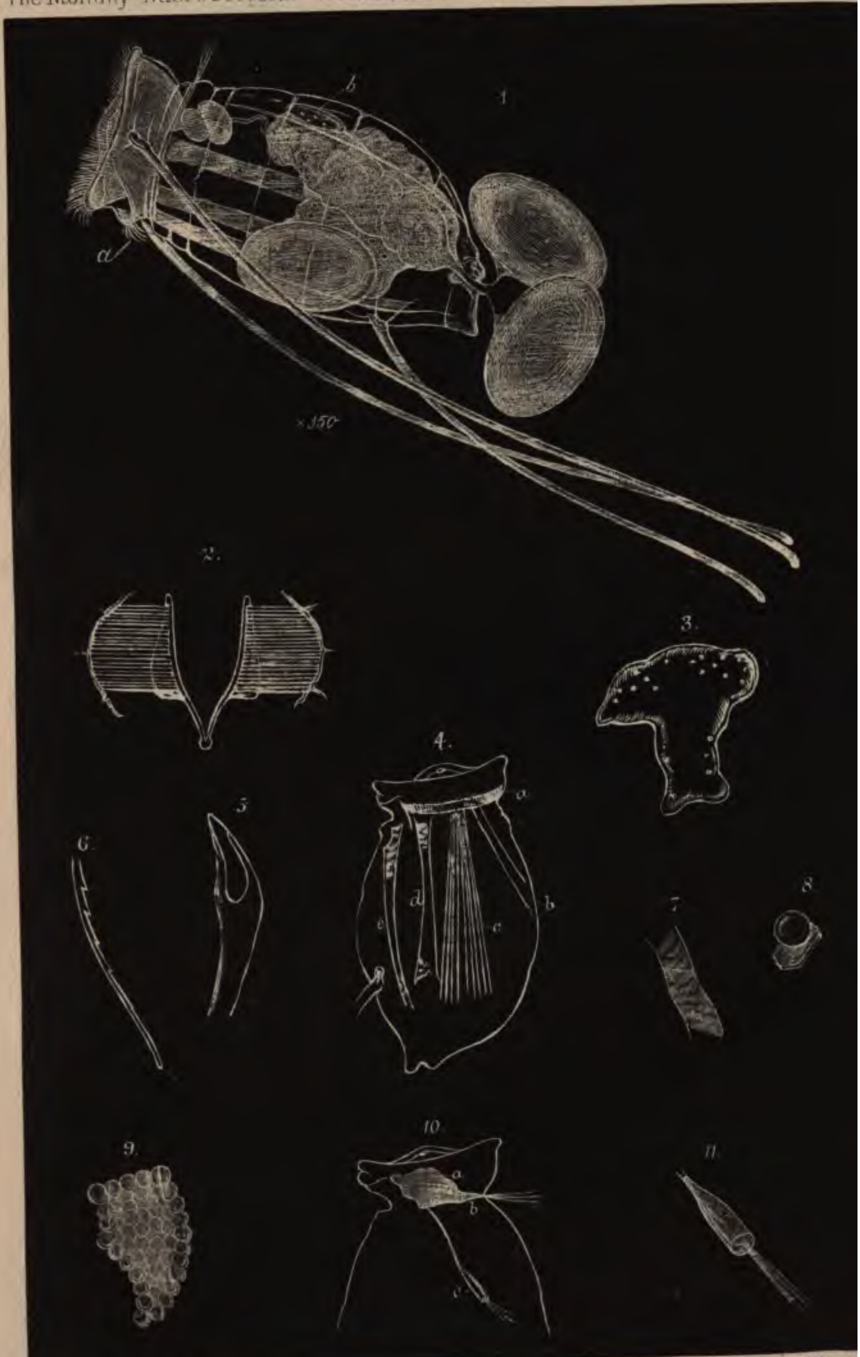
Triarthra longiseta swarmed this summer in a farm-yard pond, near Portbury, and gave me an excellent opportunity of trying to add to the rather meagre stock of information that at present exists concerning this curious rotifer, as well as of attempting to do some justice to its singular figure.

The trochal disc is of an oval shape, and bears in its centre one large conical prominence, with a lesser one on either side of it; and on each of these latter is seated a red eye. An unbroken row of cilia fringes the disc; and by means of these, Triarthra swims slowly forwards, in the direction of its length, and at the same time turns gently round its longer axis. When it reaches the edge of the water in which it is confined, or for any other reason wishes suddenly to change its course, it jerks forward three spines, two of which spring from beneath the trochal disc, and the third from the lower portion of its ventral surface. The third spine is, indeed, where the pseudopodium is usually placed, and owing to the absence of which Triarthra is forced to be perpetually in motion.

Just under the edge of the trochal disc, and on the ventral surface, is the aperture of the buccal funnel (Fig. 1, *a*). It is formed by a fold of the cuticle, and is shaped like a watch-pocket, having its edge and inner surface lined with cilia. The funnel slopes backwards and upwards towards the dorsal surface, to meet the mastax. This latter is furnished with jaws similar to those of Melicerta, and containing about twenty pairs of slender parallel rods attached to the incus (Fig. 2). From the mastax proceeds a long narrow tube to the stomach, which has very thick walls, and the lower third of which is divided from the upper portion by a deep constriction. This lower portion is densely covered with long cilia, and the food which enters it is soon afterwards expelled into the cloaca. On the upper portion of the stomach are seated two saddle-shaped gastric glands (Fig. 1, *b*; and Fig. 3), clear and almost colourless, and with what appear to be oil globules embedded in the surface.

The ovary is generally large, and stretches right across the body, usually containing one large egg and a multitude of undeveloped germs. It opens into the cloaca; and each egg, when sufficiently matured, is expelled, with a sudden violent effort, so quickly that the eye can scarcely follow the process. The eggs remain attached for some time, by slender threads, to the parent; and Triarthra is generally to be found with two or three eggs adhering to it.

The muscular system of Triarthra is very remarkable (Fig. 4). One powerful band (Fig. 4, *a*) passes round the neck, and from



Auctor del. Tuffen West lith.

W. West

Structure of Triarthra longiseta.

under its edge spring four other pairs; all are striated,—the striæ, which are frequently oblique (Fig. 7), averaging 2500 to the inch: only one of each pair is represented in the figure. One pair (*b*) is fastened to the dorsal surface: the next (*c*) consists of from eight to ten parallel fibrillæ, divided into two main groups, and stretches nearly the whole length of the rotifer. The other two (*d*, *e*) run parallel to the ventral surface; and the whole four pairs act together with surprising vigour, and enable the animal to draw its head suddenly in, and so jerk forward the spines. In Pritchard's 'Infusoria,' Triarthra is drawn in an impossible attitude, for the head is represented protruded while the spines are advanced. The spines recover their normal position by their own elasticity; for they appear to be hollow at their bases like quills, with one half cut away (Fig. 5) where they are fastened to the body. They are also notched here and there, and, especially towards the ends (Fig. 6), are occasionally roughened by minute imbrications. Five circular muscles surround the body, and by their contractions force out the retracted head.

The vascular system of Triarthra is delicately transparent, and very difficult to be seen. It exists, however, as a long, tortuous double thread, or tube, which springs from the cloaca, passes up either side of the body close to the surface, and ends in a mesh of convolutions below the neck. I could only detect one vibratile tag on each side of the neck, and close to the spot from which the muscle (*c*) springs. I have always failed to discover a contractile vesicle, but it may be very small, and hidden between the ovary and stomach.

By bringing into focus the central and inner portion of the head, a bluish and roughly rhomboidal mass (Fig. 10, *a*) may be seen, above which are placed the eyes, and a prolongation from which (*b*) extends to a fossa beneath the neck bearing long setæ. From this mass, also, which is probably a cerebral ganglion, may be traced, on either side of the body, a curved thread, which ends in a rocket-shaped base (*c*), and Fig. 11, bearing setæ. These are doubtless tactile organs; precisely similar ones exist at the hinder extremity of *Synchœta tremula*.

Each eye (Fig. 8) is a clear colourless sphere of $\frac{1}{8000}$th of an inch in diameter, resting on, and partly embedded in, flat plates of red pigment.

Towards the latter end of November, all the specimens I captured had winter eggs (Fig. 9), which are of a peculiar shape, and are protected by a thick layer of yellowish transparent cells. The average length of a full-grown Triarthra is $\frac{1}{140}$th of an inch.

VI.—*Professor Owen on Magnetic and Amœbal Phenomena.* By LIONEL S. BEALE, M.B., F.R.S., Fellow of the Royal College of Physicians, &c.

IF general agreement on fundamental principles amongst authorities who differ from one another in not unimportant particulars can establish proof, the physical theory of life should be accepted as true. But it may be doubted if one unprejudiced person accustomed to weigh scientific evidence has yet been convinced of the truth of this doctrine by the facts and arguments advanced in its favour.

Every one is interested with the scientific speculations of our day; but, although not a few of the arguments advanced are calculated to prejudice the judgment, some of them are more likely to provoke the smiles even of believers than to convince the reason of those most open to conviction. Men eminent among philosophers, chemists, physicists, geologists, zoologists, and physiologists, seem to be vieing with one another in trying to force the acceptance of the dogma that life is but a mode of ordinary force, and that the living thing differs from the non-living thing not in quality, or essence, or kind, but merely in degree.

But is it not most remarkable that, of the many great authorities who support the physical theory of life, not one has succeeded in explaining to us the difference between a thing *living* and the same thing *dead*? And if those who advocate this notion do not believe in the actual annihilation of force when the living thing passes into the dead state, why do they not demonstrate the form or mode which the departing life-force assumes? Until this is done, the physical theory rests on no scientific basis whatever; it is a mere dogma, and, like other dogmas, must be promulgated by pure authority. Owen has lately avowed his belief in it; but, unlike many of its advocates, he admits that "on one or two points" proof is wanting. May I venture without offence to examine some of the grounds of the Professor's qualified belief?

Professor Owen says that there is nothing peculiar to living things in their power of selecting certain constituents, because a magnet *selects* also. It attracts towards it only certain kinds of matter. Nor, he further observes, is death characteristic of things living only; for if the steel be unmagnetized, is it not "dead"? "Devitalize the sarcode (living amœba), unmagnetize the steel, and both cease to manifest their respective vital or magnetic phenomena. In that respect both are 'defunct.'" "Only," naïvely remarks the same authority, "the steel resists much longer the surrounding decomposing agencies." But is such reasoning as this likely to

have weight with any one who has seen an amœba moving? Is such a person likely to be convinced that there is any true analogy whatever between its movements and those exerted by a magnet?

But I will allow Professor Owen much more than he will venture to accept, and shall yet be able to show that there is no true analogy between the amœba and the magnet. If the magnet moved itself from place to place; if it divided and multiplied; if every part of it were capable of moving in every direction; if it were able to select salts of iron, and then decomposed these and appropriated the iron to itself, so that, from a very little magnet, it grew into a big one, there would still be no real analogy between it and an amœba; because you can magnetize and unmagnetize the steel as many times as you like, but you cannot revitalize an amœba once defunct. If you were to take a quantity of dead matter of defunct amœbæ, and place it near a living amœba, it would not be reanimated. The living amœba might take up, bit by bit, the products of disintegration, and thus increase; but this is a very different thing from vitalizing a *mass of organic matter* as a mass of steel may be magnetized. Dead amœbal matter cannot be induced to *live* under circumstances at all parallel with those under which the "defunct" steel can be remagnetized. We are therefore compelled to conclude that the amœbal phenomena are different in their very nature from the magnetic phenomena.

Looking from this point of view, it is *not* at present "conceivable that the same Cause which has endowed His world with power convertible into magnetic, electrical, thermotic, and other forms or modes of force, has also added the conditions of conversion into the vital mode." The question is still open, and the analogy supposed to exist between vital and magnetic, electrical, thermotic, and other forms or modes of ordinary force, has yet to be shown. If the magnet is the closest analogy that can be drawn between non-vital and vital actions, very little advance, it must be admitted, has been made during the last fifty years. Professor Owen is surely injuring the cause he hopes to serve. The Egyptian priests, in referring the origin of the universe to a single Egg, were far wiser in their generation, because in those days no one could prove that the universe did not so originate; while in these days people who can examine magnets and amœbæ will soon convince themselves that there is no analogy whatever between the magnetized steel and the active, living, moving, organic substance they see extending different parts of itself in many directions at the same instant.

Between amœbal phenomena and mammalian phenomena there is a close analogy; for, at the earliest period of being, the phenomena of a mammal might be truly described as *amœbal*. On the other hand, magnetic actions exhibit no *closer* an analogy to the amœbal

than they do to mammalian phenomena, for they exhibit no analogy whatever to either.

We are not one step nearer to the "vitalizing of the primary jelly-speck or sarcode-granule by the operation of a change of force forming part of the constitution of Kos-mos" than we were before Owen accepted the doctrine of the daily and hourly formation of living beings out of inanimate matter by the conversion of physical and chemical into vital modes of force. And it is very remarkable that even Owen is unable to suggest a better instance of the analogy between physical and vital actions than is afforded by magnetism. The remarks he has offered might have been made a century ago, and some of the very same arguments he has adduced, advanced in their favour. Facts and observations have of late multiplied enormously; but it is evident that no arguments in favour of the physical theory of life are to be deduced from these, or the Physico-chemical school would very soon have put them forward, in place of the plaintive monotones people are becoming so tired of hearing. Driven to extremities, they are at last compelled to discard observation and experiment, and announce the advent of a new philosophy. An expectant multitude is delighted with the boldness of their speculations and the imposing grandeur of their prophetic disclosures. In silence it contemplates the marvels of the new creation hourly springing into existence, built up *ab initio* by epigenetic "Nomogeny," the offspring of which is gradually to advance until, in the ages yet to come, it shall attain perfection by "Formifaction" and "Derivation."

NEW BOOKS, WITH SHORT NOTICES.

L'Origine de la Vie, par le Docteur Georges Pennetier, ouvrage illustré de nombreuses vignettes sur bois, avec une Préface par le Dr. F. A. Pouchet. 3rd edition. Paris, J. Rothschild, 1868.—At the present moment, when the question of spontaneous generation is to some extent a problem, receiving the grave attention of many of our best microscopists, a work like that of M. Pennetier's is of considerable service; for we doubt not there are many among our readers who are unfamiliar with the evidence which the advocates and opponents of Heterogeny have brought forward. M. Pennetier is himself a very distinguished explorer in the field of research; and as his work has been revised and prefaced by no less a person than the great champion of Heterogeny, M. Pouchet, it merits a careful examination. Those who have read Professor Hughes Bennett's article* "On the Molecular Origin of Infusoria," are aware that the dicta of M. Pasteur, which have held almost universal sway over the minds of English *savans*, are by no means so well based in reason as people are generally led to suppose. As the work before us, therefore, gives a very lucid and comprehensive account of the whole subject, it may not be out of place to lay a few of its details before our English workers.

The preface, by M. Pouchet, is cleverly written, but abounds in generalities which are to some extent foreign to the question, whether life-forms can be generated spontaneously by the fermentation of organic matter. It is chiefly remarkable as a severe diatribe against M. Pasteur and some other members of the French Academy. The book itself comprises thirteen chapters, which treat consecutively of the various branches of the great controversy. The titles of these chapters give a clue to their contents, and are as follows:—Introduction; Microscopic Life; History of Spontaneous Generation; Conditions of Spontaneous Heterogenic Genesis; Formation and Development of the Spontaneous Ovule; It is not Derived from the Atmosphere; The pretended Incombustibles; Demonstrations in the Open Air; Demonstrations in Charcoal Vessels; Development of Yeast; Mutations of Matter; Bibliography.

Some of these chapters contain very old material, but a few of them embrace a good summary of the published investigations of the last five years, and of papers which are scattered through different foreign journals and 'Transactions.' The chapter on the development of yeast—a point which is even yet not quite cleared up—strikes us as being very good; and it certainly records some very remarkable experiments in proof of the author's opinion. The following passage is an example:—"To prove that the molecules (*grains*) of yeast are not derived from the atmosphere, and to

* 'Popular Science Review,' January, 1869.

incontestably establish their spontaneous generation, M. Pouchet performed the following experiment, to which we call attention:—'We plunged,' said he, 'a flask to the bottom of a vessel containing a decoction of malt which had been boiled for six hours; there it was completely filled with this decoction, and it was carefully closed before it was brought to the surface. Afterwards, with excessive precaution, the circumference of its mouth was luted with a compound of copal varnish and vermilion, and thus we were certain that the flask was hermetically sealed. At the end of six days—the external temperature having an average of 18° Centigrade—we saw a slight deposit of yeast at the bottom of the flask. The seventh day, the temperature of the laboratory being suddenly raised to 27° C., the flask burst with a loud report, and its upper half was blown to some inches' distance. Then we saw, with the naked eye, that a notable quantity of yeast had formed in the liquid under experiment, and the microscope demonstrated the fact beyond question.' 'If the spores had pre-existed in the liquid, it is admitted by all authorities that a moist temperature of 100° C., prolonged for six hours, would have completely disorganized them. The yeast formed had, therefore, some other origin. It was not derived from the air, since the flask was completely removed from air. It was therefore spontaneously formed.' 'M. de Vaureal, who admits the importance of this experiment, and regards it as being a fundamental one, nevertheless complains of the very short time during which the flask was suspended in the liquid, and remarks, with some fairness, that it would have been more precise to have kept the flask in the liquid during the entire duration of ebullition. But M. Pouchet having in one of his experiments kept the flask in the liquid for ten minutes, M. Vaureal's objection loses its apparent force, and has merely a formal importance.'"

The experiment detailed above by the author is one which, though of a simple character and easily tried by any one, is—the fact of the destruction of spores by heat being granted—a remarkably conclusive one, and it gets over one of the great objections of the panspermists. The doctrine of the latter, that the air is charged with the spores of fungi and the ova of Infusoria, is one more easily asserted than maintained. As we know from Dr. Hughes Bennett's experiments, the existence of atmospheric germs is extremely difficult to prove. On this point the author makes the following very pertinent remarks:—"If moreover the air, as the panspermists allege, is the vehicle of the germs of the plants which appear in fermentation, there would be no difficulty in discovering them; their numbers would be considerable enough, and their size is most frequently very appreciable. M. Pasteur affirms, it is true —M. Pasteur always *affirms* — that we may distinguish the spores of the common moulds in the air; but to affirm is not to demonstrate, and that which the eminent chemist fails to do, botanists are doing every day. Hoffmann recognizes clearly the spores of *Cladosporium* and *Stemphylium;* M. Pouchet those of

Penicillium, and *Ascophora*, and *Aspergillus*." The argument here being, that though the spores of these ferment-plants are easily recognized, M. Pasteur has not demonstrated their existence in the air, though he asserts that they are floating in thousands in the atmosphere.

In his chapter entitled the "Last Refuge of the Panspermists," the author criticises a number of M. Pasteur's experiments, and turns the tables against his opponents. Here, quoting M. Pouchet, he points out (p. 259) a suggestive fact, which, whatever its real explanation, is at all events in direct opposition to the supposition that the germs of Infusoria are derived from the atmosphere. "Decisive experiments," says M. Pouchet, "have demonstrated to me that by placing the same air in contact successively with different substances, these latter, turn by turn, produce quite distinct groups of plants. And these curious researches may be prolonged to any degree, for they are limited only by a chemical alteration of the air." A cubic centimètre of air was successively (by means of suitable contrivances) placed in contact with a maceration of flesh, and it produced monads; with a maceration of asparagus, and it produced bacteria; with a maceration of hay, and it produced *Kolpodæ;* and, finally, with a maceration of glue, and it produced *Penicillium*." Further on, attention is directed to Pasteur's absurd objection, referred to by Dr. Bennett (*vide supra*), that the necks of the flasks in the mountain experiments were not broken properly; and the author shows that the experiments, when repeated under Pasteur's conditions, gave the same results as at first. We have, however, said enough to show that this volume is worthy of notice by all, whether advocates or opponents, who are interested in this great question. One of the most useful features in the volume is the copious Bibliography in the Appendix. This is a very carefully prepared list of the works of foreign writers on the subject of Spontaneous Generation.

Dell' Anatomia Sottile dei Corpuscoli Pacinici del' Uomo. Ed. Altri Mammiferi E. Degli Ucelli con considerazione Esperimentali Intorno Al Loro Ufficio dell Dottore G. V. Ciaccio, Professore di Fisiologia Nella R. Università di Parma. Torino Stamperia Reale, 1868.—There is still unquestionably a good deal to be made out as to the relation of the nerves to the Pacinian bodies, and, indeed, as to the functions of these bodies themselves; but we do not think that Professor Ciaccio, who has very courteously presented us with a copy of his excellent memoir, has cleared away all our difficulties. Still the monograph of the Italian Professor, while it supplies us with very little more of detail than is given in Mr. Bowman's capital article in 'Todd's Cyclopædia,' is nevertheless a most comprehensive account of the whole subject. It is divided into several sections. First, we have the history of the discovery of these corpuscles; then comes an account of the different fluids for mounting specimens; such as ammoniacal aqueous solution of carmine, glycerine and acetic

acid, osmic acid, oxalic acid, chloride of gold, oxalate of ammonia, nitrate of silver, Lockhart Clarke's acetic acid and alcohol, Mueller's liquid, chromic acid, and alcohol. In the next place the author commences his description of the Pacinian corpuscle, giving a distinct section to each of its constituents. His descriptions of the minute anatomy extend over more than forty pages 4to, and are accompanied by five plates, with nearly forty beautifully-drawn figures of the different parts of the corpuscles, as seen with powers varying from 300 to 600 diameters. The following are the more important results which the author arrives at:—

1. Every Pacinian corpuscle, whether of the mammifera or birds, is in reality formed of three parts,—an external envelope, more or less compound and intricate; an internal nucleus or club; and a nervous fibre.

2. The envelope of the Pacinian corpuscles in the mammifera differs, by certain peculiarities, from those of birds. In the former it consists entirely of many membranous layers, or capsules, enclosed the one within the other, of which the outer layers have larger spaces between them than the internal; in the latter, besides that the capsules are much less in number and very slightly separated, they have in addition a peculiar connective substance, which occupies the space between the capsule and the internal nucleus or club.

3. Generally from one capsule to the other spring fine intermediate membranes, which divide each of the larger spaces into many small ones, which are normally filled with a clear albuminous fluid.

4. The nuclei of the capsule, as they are generally called, are nothing but true connective-tissue corpuscles.

5. In the Pacinian corpuscles of mammifera, the above-mentioned intercapsular ligament is of two kinds; one is but a very minute canal, through which runs one or two extremely fine blood-vessels; the other is composed of a certain number of connections between capsule and capsule, together with ramifying connective-tissue corpuscles. Of the two forms of ligament, the first is frequently to be met with in the Pacinian corpuscles of man; the second in those of the cat. In the corpuscles of birds there has never been found any but the second form of intercapsular ligament.

6. The internal club-shaped body consists of two distinct parts,—a very fine envelope, and a homogeneous connective substance. From the inside of the envelope spring several minute membranous filaments, which insinuate themselves into its substance, and divide it with great regularity into numerous small portions, and thus help to give it sufficient solidity and support.

7. The nuclei from which the internal "club" is nourished, are situated between the membranous envelope and the connective homogeneous substance.

8. In the Pacinian corpuscles of birds, the internal club-shaped body is probably of a less complicated texture than that of the Pacinian corpuscles of mammifera, from which it is chiefly

distinguishable, because it is less provided with nuclei, which are usually arranged one after the other in two long rows, placed one at one side and the other at the other side of the club, and because it is almost always observed to be undivided.

9. The internal club-shaped body takes its origin from the extensive proliferation of the sheath enclosing the nervous fibre, which proceeds to the Pacinian corpuscle.

10. From the Pacinian corpuscles of mammifera there usually arises one nervous fibre, and very rarely two. In those of birds, there are never more than one fibre.

11. Generally the nervous fibre loses its double contour in the act of penetrating the internal club; sometimes, however, it retains it for a short distance after penetration. The loss of the double contour in the nervous fibre occurs suddenly, not gradually.

12. In the Pacinian corpuscles of the mammifera the nerve-fibre rarely terminates without dividing. In those of birds the division of the nerve-fibre has very seldom been seen.

13. The termination of the pale nerve-fibre never occurs but in cells, the numbers of which vary according to the number of filaments into which the nerve-fibre divides itself.

14. From the medullary sheath outwards, the same constituents are found in the pale nerve-fibre as in that having a double contour, of which it is the immediate continuation. The limiting membrane of the pale fibre of the Pacinian corpuscle has this peculiarity—it is without nuclei. It is continuous, in the same manner, with the delicate membrane of the terminating-cells.

15. The pale fibre sometimes appears in long thin filaments, which can be traced from the nucleus to the terminating-cell. This circumstance gives rise to the reasonable presumptiom that the axis cylinder of a nerve-fibre may consist of various representative filaments of the minute processes of many nerve-cells.

16. In man the Pacinian corpuscles of the hand and foot are abundantly provided with blood-vessels, which not only penetrate the corpuscles from both sides, but from other superficial points. The number of blood-vessels is greater in the Pacinian corpuscles of the foot than in those of the hand.

17. In the human Pacinian corpuscles of the two parts mentioned, there is almost always a corresponding capillary, which, as it were, touches the upper extremity of the internal club-shaped body.

18. The Pacinian corpuscles of the mesentery of the cat, and those in the foot of the horse and the bull, possess but a small number of blood-vessels, which, as a rule, enter the corpuscle by the same side where the nerve-fibre enters, and very rarely at the opposite side.

19. In the Pacinian corpuscles of the bird, and particularly in those of the pigeon, which occur in that short tract of skin which borders the beak, the blood-vessels come from the vessels of the surrounding parts, and when they have reached the external surface of the corpuscle, lose themselves in it, with many convolutions,

without, however, penetrating too far into the substance inserted between the capsule and the internal club-shaped body.

20. The funiculus, or stalk, of the Pacinian corpuscle consists essentially of a medullary nerve-fibre, enclosed in its own sheath, of a variable quantity of connective tissue with longitudinal fibres, and of one or two extremely small arteries.

21. The function of the Pacinian corpuscles is essentially a special one, and different from that of other terminating nervous corpuscles. Its nature must be said to be unknown.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Development of the Flower in Cruciferæ.—A paper on this subject has been laid before the Academy of Sciences of Vienna by Herr Wretschko. He states that the young inflorescence of all these plants has the appearance of an extended and slightly-arched axis, from whose border flower-buds generally devoid of tracts may be seen differentiating. It is not uncommon to meet rudimentary tracts fixed to the buds, and of contemporaneous origin with them, which afterwards disappear without leaving any trace. Some species also have two rudimentary lateral leaves placed in front of the bud, and which seem never to be present when the tracts are. These leaves are earlier in origin than those of the calyx. This latter commences occasionally by the posterior sepal, but oftener by the anterior one; the median pair are very soon followed by the lateral pair. The four petals are developed simultaneously, and are soon followed by broad but small elevations, which are the first indications of the lateral stamens; after which the receptacle becomes arched, and soon passes into a sort of square with rounded angles, on which appear four elevations (not in front of the petals), the first rough sketch, as it were, of the four long stamens. The progress of development shows nothing in favour of the theory of abortion, but it does not allow of our forming the conclusion that there is a common origin for each pair of long stamens, previous to that of the anterior and posterior sepals; consequently the theory of division of the median process which developes each pair of stamens is inadmissible.—*Sitzungsber der Kaiser Akad. der Wissen in Wien.* LVII Band. VII Heft.

The Vitality of the Tissues in Sponges.—M. Leon Vaillant, following up the inquiries of Bowerbank, Lieberkühn, and Oscar Schmidt, has been trying various experiments to determine the manner in which loss of substance is repaired in sponges. He has been trying to graft the sarcode in various ways. The species on which he operated especially is one of the *Corticatæ* of Schmidt, the *Tethea lyncurium* Lamarck, whose histology and regular form he considers more suited to the nature of the research than the species of *Halichondria*, employed by Dr. Bowerbank. The objections to it are—(1) that it does not live

long in captivity; and (2) that it inhabits considerable depths, such as those of the third and fourth zones of Audouin and Milne Edwards. M. Vaillant has attempted to isolate the cortical substance and also the medullary substance, and he has made numerous sections to determine the nature of the process of cicatrization; he has engrafted the substance of *Tethea* on itself, and the substance of various sponges of the genera *Sycon*, *Halichondria*, *Reniera*, *Polymastia*, on *Tethea*. He draws the following conclusions from these experiments:—1. The two substances which enter into the composition of *T. lyncurium* are equally capable of reproducing each other, the isolated medullary substance reproducing the cortical, and reciprocally. 2. The vitality of the cortical substance is greater than that of the medullary substance, a fact in relation to its histologic constitution. When detached it is capable of forming prolongations which can re-unite it to the sponge. Its contractility is also more decided than that of the cortical substance, if indeed this latter has any contractility at all. 3. The cortical portion of the sponge has a special office—that of protection. 4. Grafting from individual to individual in these species is easily effected, but requires some little care for its successful operation. 5. The graft of a different genus on *Tethea lyncurium* has not yet been effected.—*L'Institut*, January 27th.

The Villi of the Small Intestine.—In a paper read before the Vienna Academy of Sciences, Herr C. Heitzmann states that the form of the villi depends on the contraction of the intestinal canal, and varies from that of a flattened cylinder to that of a cone. The epithelial lining is readily detached, and this over a large extent of surface, by the contractions of the muscular coat. The stroma of most of the villi encloses cells, whose protoplasm exhibits granules of a deep green colour and a highly refractive nature. These he regards as chlorophyll corpuscles.

Mechanism of Flight in Insects.—M. Marey has been applying the graphic method to determine the nature of the process of flight in insects; and although the subject is hardly a microscopic one, the paper may be referred to as one of high interest to the naturalist. Some of the experiments made to determine the uniformity and velocity of the movements of the wings of insects, are very interesting. M. Marey has replied to the three following questions:—1. What is the frequency of the movement of the wing in insects? 2. What are the different successive positions that the wing occupies in executing its complete revolution? 3. How is the motor force which maintains the body in the air maintained? The paper is abundantly and well illustrated, and will be found in Robin's '*Journal de l'Anatomie*,' Février, 1869.

The Movements of the Intestines.—The same journal contains an application of the graphic method to this question, and is full of interest.

Mycoderms in the Urine of Diabetic Patients.—M. de Séynes describes the mycoderms found in the saccharine urine of diabetic patients, and states that the mycoderms may be detected in urine

which contains no sugar. He has figured the species found by him, which is really only *Mycoderma vini*. The objection to his experiment is that the time during which the urine had stood after discharge from the bladder is not stated.—*Vide Journal de l'Anatomie*, No. I., 1869.

The Fecundation of Cephalopods.—This process has been very carefully studied, and is described in a memoir (Linnean Society of Bordeaux, 1868) by M. A. Lafont. The author states that of thirty specimens of *Ommastrephes sagittatus* examined by him, four females bore at the base of their branchiæ a packet of spermatophores, divided into two bundles, fixed in the internal wall of the sac by an oval placenta, and so placed as to be in contact with the nidamentary glands, at the level of the opening of the oviduct. A fifth female also bore spermatophores, but the bundle was fixed upon the nidamentary glands, and a little above the opening of the oviduct. The spermatophores were united by a sort of gelatinous matter, which bound them together. In all the males, he found at the base of the penis-orifice a large pouch filled with spermatophores, united by their bases into bundles placed in stages one over the other. At the side of this pouch, and in communication with it, was found a sort of convoluted gland communicating with the testes. He found in the upper part of this organ, and in the canal of communication with the penis-pouch, very long spermatophores, free and in course of formation, while the lower part (like the deferent canal) contains only free spermatozoa.

The Nerves of the Bladder and Sphincter Ani.—This very important point in human histology has a paper devoted to it by M. Masius. *Vide Bull. de l'Acad. Royale de Belgique*, 2e série, t. XXV., No. 5.

The Anatomy of the Crayfish.—In the third part of his fine memoir on the anatomy of this crustacean, M. Victor Lemoine deals with the glandular system generally,—the cutaneous pigment, the blood corpuscles, the intestinal glands, hepatic gland, testicle, and the "green gland." This last structure has puzzled most anatomists, but the author has given a very elaborate description of it.—See *Annales des Sciences Naturelles*, t. X., 1868.

The Anatomy of the Trichodactylus.—M. A. L. Donnadieu has an article on this genus of the Acari in the number of the '*Annales*' referred to above. The author gives a detailed account of the external anatomy of the genus, and supplies some excellent illustrations. He thinks that *Trichodactylus*, *Sarcoptes*, and *Psoroptes*, approach each other by common characters, which place them in a distinct group from the *Tyroglyphæ*, for these latter have four pairs of limbs, terminated by hooks or suckers, while the former have one or both pairs of posterior feet terminated by one or more long hairs.

A New Crustacean of the Genus Limnoria has been described by M. Hesse, who calls it *Limnoria xylophaga*. The author describes its zoological characters and its anatomical structure very minutely, giving several drawings of them. He states that the habits of the

new species are exactly the same as those of *Limnoria terebrans*, with which it is generally confounded. This co-existence has led to many mistakes. While both species are, he says, very common, it is to be borne in mind that the *L. terebrans* is much commoner than the other. The new one, like the old, swims with great facility; it turns on its back, which then forms a sort of keel, and, using its thoracic feet as oars, it employs its abdominal false limbs as a rudder. When it walks it moves much more slowly, and when touched it rolls itself into a ball, like certain other species. It attacks nearly all submerged woods, but it especially favours young woods and the French pine.—*Annales des Sciences*, t. X., 1868.

Researches on the Wing of the Orthoptera is the title of a paper in the above journal, by M. H. de Saussure. The details of the peculiar mode of plication of the wing are fully entered into.

The Development of Oblique Leaves is the subject of a paper by Dr. Wilder in the last volume of the 'Proceedings of the Boston Society of Natural History.' The author thinks that the obliquity of leaves is not to be explained by reference to external operations, but is the expression of certain definite internal qualities.

The Thalassicollidæ.—Dr. G. C. Wallich has a very interesting paper on this group in the 'Annals of Natural History' for February. One of the points discussed is the relation of *Thalassicolla nucleata* to *Noctiluca.* It would be impossible to abstract this paper.

The Gonidia of Lichens changing into Zoospores.—This is a paper by MM. Famintzen and Boranetzky, and is translated in the '*Annals*' for February by the Rev. W. A. Leighton. The authors give experiments to prove this singular transformation, and they tabulate the following propositions:—1. Not only Algæ and Fungi, but Lichens are provided with zoospores. 2. Zoospores have been found in three very different genera of Lichens, *viz. Physcia*, *Cladonia*, and *Evernia;* and as these genera were selected undesignedly, it is probable that zoospores exist in all other lichens provided with chlorophyll. 3. We have demonstrated the existence of free gonidia with the unicellular alga, *Cystococcus* of Nägeli; consequently this is not a distinct genus, but only a phase of development of a lichen. 4. The culture of the free gonidia of the three species above, led us to expect that other lichens would present forms corresponding with rudimentary Algæ, and our researches proved this. Vertical sections of the thalli of *Peltigera* and *Collema* cultivated on moist earth showed the filaments in disintegration, the augmentation in size of the gonidia, and their transformation into glomerules composed of spherical cells. The gonimic cellule of *Peltigera* and *Collema* continued to live when separated from the thallus. Those of *Peltigera* were identical with an alga called *Polycoccus;* those of *Collema* produced organisms similar to *Nostoc.* Consequently these three genera of Algæ, hitherto regarded as different and distinct, are in reality only the gonidia of lichens in a state of development when separated from the thalli which produced them.

The Homologies of the Dental Plates and Teeth of the Proboscidiferous Mollusks.—This is an excellent paper in the 'Annals' for February, by Dr. J. Denis Macdonald, F.R.S. The paper is accompanied by a plate.

Comparative Anatomy and Physiology of the Retina.—Those of our readers who desire to familiarize themselves with the work that has been done up to the present on this important subject, should read the able review (by a well-known provincial anatomist) in the last (January) number of the 'British and Foreign Medico-Chirurgical Review.' It is certainly the most comprehensive and lucid exposition of a complex question that we have seen for some years.

NOTES AND MEMORANDA.

A New $\frac{1}{2}$-inch Object-glass has been constructed by Mr. Chas. Collins, of Great Titchfield Street, and deserves the attention of working microscopists. It is especially adapted to investigations on Foraminifera, &c.; but it works admirably with certain anatomical preparations. It has a low angle (40°) of aperture, but gives an excellently flat field, and has great penetration. It bears the test of the three eye-pieces well, and is in all respects an admirable working lens. Mr. Collins does not intend this glass to be employed in diatom work, for which some think a $\frac{1}{2}$-inch suitable; nevertheless, it works well with the Podura scale. Messrs. Powell and Lealand made an objective of the kind some years since, but they did not, we believe, follow up the manufacture. Mr. Collins has revived the idea; and we think that naturalists and medical men will find his $\frac{1}{2}$-inch a most useful one.

Quekett Club Reports.—Mr. John Hopkinson requests us to correct an error which occurred in the report in our last issue. At page 133, line 15, the word "race" should be "Hydrozoa," and at line 21 the word "Asterida" should be "Actinozoa." It is only fair to ourselves to state that these were not printer's errors, but existed in the original "copy." As we are extremely anxious to avoid mistakes, we trust that the secretaries of societies will read their reports carefully before transmitting them to us for publication.

The Old Change Microscopical Soirée.—At this gathering, the number and interest of the microscopic objects exhibited far exceeded the average of such meetings. The "Synopsis" which was circulated among the guests was admirably arranged. It ought to be adopted at every such assembly, as it enables a visitor, who cannot possibly examine some thousand objects, to select with ease those specimens in which he feels a particular interest.

Tinting Vegetable Tissues.—Some interesting observations on this point have been made recently by Dr. W. R. M'Nab. These we hope to lay before our readers in an early number.

The Developmental Relations of the Lower Fungi.—It is within the reach of all of our readers to make observations on this point. The subject is just now of the utmost importance; and as moulds are as abundant as microscopes, we hope ere long to receive numerous communications on the relations of the different forms of *Mucor*.

Dust as seen by the Microscope.—In a paper lately contributed to the Literary and Philosophical Society of Manchester (whose report, by the way, reaches us too late for insertion in this number), Mr. J. B. Dancer stated that he has been examining the dust of the air at different heights, and has established some important results. In every instance molecular activity was abundant; but the largest proportion of moving animal organisms and of vegetable structure was found at a height of about five feet from the ground.

Diatomaceæ from Danish Greenland.—At the meeting of the Botanical Society of Edinburgh on the 14th of January, Professor Dickie gave an account of the specimens collected by Mr. Robert Brown. All the species recorded were British, with the single exception of *Hyalodiscus subtilis*, originally described by the late Professor Bailey, from Halifax; found also on the shores of North-west America, and now on the shores of Greenland.

Chair of Botany in the Dublin College of Science.—This Chair has been filled by the appointment of Professor Wyville Thomson, of Queen's College, Belfast. Dr. Thomson's name is so familiar to all naturalists, that it is unnecessary to comment on his fitness for the office he now holds.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.†

February 10.

Annual Meeting.—James Glaisher, F.R.S., President, in the chair. —The minutes of the last meeting were read and confirmed.

The Treasurer's Report was then read, as on the next page; likewise the Report from the Cabinet and Library Committee, the chief facts of which are embodied in the President's Address.

The adoption was moved by James Hilton, Esq., seconded by W. T. Suffolk, Esq., and carried unanimously.

The President then delivered his Address,‡ at the close of which Chas. Tyler, Esq., moved, and E. G. Lobb, Esq., seconded, "That the cordial thanks of this meeting be given to the President for the admirable Address he has just delivered."

* Secretaries of Societies will greatly oblige us by writing out their reports legibly—especially the technical terms—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

† Report supplied by the Secretaries. ‡ See p. 141.

Dr. THE TREASURER IN ACCOUNT WITH THE ROYAL MICROSCOPICAL SOCIETY. *Cr.*

Dr.	£	s.	d.	£	s.	d.
Balance at Bank of England, Feb. 12, 1868				241	14	4
Sale of 'Transactions'				8	8	0
Deposit withdrawn from Union Bank				168	0	0
Interest on ditto				1	5	7
Fees on Admission				56	14	0
Compositions				54	12	0
Subscriptions, 1862	£1	1	0			
,, 1863	1	1	0			
,, 1864	3	3	0			
,, 1865	3	3	0			
,, 1866	6	6	0			
,, 1867	7	7	0			
,, 1868	170	2	0			
,, 1869	67	4	0			
,, 1870	1	1	0			
				260	8	0
Dividend on 860*l.* 19*s.* 10*d.* Consols, July 5, 1868 ..				12	11	10
,, 162*l.* 8*s.* 7*d.* ,, ,, (no Tax)				2	8	8
,, 1023*l.* 8*s.* 5*d.* ,, Jan. 5, 1869 ..				14	19	4
Donation to Library Fund, by Rev. J. H. Ellis				0	10	0
				£821	11	9

Cr.	£	s.	d.
'Journal,' Dr. Lankester	217	7	9
,, Mr. Hardwicke	23	2	9
Library	32	11	9
Rent	12	16	11
Instruments and Seal	25	11	3
Furniture	2	3	3
Oil	5	4	7
Stationery	5	11	0
Printing	23	16	0
Assistant-Secretary, Salary	49	7	0
,, Petty Cash and Postages	37	11	2
Hall Porter	6	10	0
Collector's Commission	2	12	10
Soirée Expenses, 1867	22	17	6
,, 1868	75	0	3
Subscription to Ray Society	1	1	0
Insurance	1	16	0
Purchase of 11*l.* 3*s.* 3*d.* Consols	10	10	0
	£555	11	0
Balance at Bank of England	234	19	1
,, in hands of Treasurer	7	19	8
,, ,, ,, for Investment	23	2	0
	£821	11	9

We, whose names are hereunto subscribed, hereby certify that we have this day audited the Treasurer's Account, above written, and examined the same with the Books and Vouchers, and find the same correct; and that the Balance is 266*l.* 0*s.* 9*d.* to the credit of the Society, of which 234*l.* 19*s.* 1*d.* is at the Bank of England, and 31*l.* 1*s.* 8*d.* in the hands of the Treasurer. Dated 25th January, 1869.

CHARLES TYLER, } *Auditors.*
THOS. W. BURR, }

NOTE.—The Auditors suggest that in future the Accounts of the Society should be made up from 1st January to 31st December in each year, and not from one Annual Meeting to another, as at present.

This vote of thanks being carried unanimously, was briefly acknowledged by the President.

Mr. Slack drew attention to a drawing on wood of the lips of a blow-fly, made by Mr. Suffolk; he remarked upon its superiority to the views of this subject which had been hitherto published, and stated that it would shortly appear in the Journal.

Dr. Lankester moved as follows:—"That the following alteration be made in Bye-law 56; that after the word 'Society,' 'and of no other matter whatsoever' be inserted, instead of 'and of such other matter as the Council may determine.'"

As this motion was not seconded, it fell to the ground.

Mr. Slack gave explanations of the reasons which had influenced the Council in making the new arrangements for publishing the Society's 'Transactions.' Remarks on the same subject were made by the President in his Address.

The following gentlemen were then elected officers, &c., for the ensuing year, and the Rev. J. B. Reade, F.R.S., was inducted by Mr. Glaisher into the President's chair, amidst the applause of the meeting:—

OFFICERS AND COUNCIL.

President.—*Rev. J. B. Reade, M.A., F.R.S. *Vice-Presidents.*—*James Glaisher, F.R.S.; *L. S. Beale, M.D., F.R.S.; W. B. Carpenter, M.D., F.R.S.; G. C. Wallich, M.D., F.L.S. *Treasurer.*—*Richard Mestayer, Esq. *Secretaries.*—H. J. Slack, F.G.S.; Jabez Hogg, F.L.S. *Council.*—*Arthur Farre, M.D., F.R.S.; *Arthur E. Durham, F.R.C.S.; *Henry Lawson, M.D.; *James Murie, M.D., F.L.S.; *Charles Tyler, F.L.S.; Charles Brooke, M.A., F.R.S.; W. H. Ince, F.L.S.; Henry Lee, F.L.S.; Ellis G. Lobb, Esq.; John Millar, M.D., F.L.S.; Major Owen, F.L.S.; F. H. Wenham, C.E.

It was moved by Mr. Ince, seconded by Chas. Brooke, F.R.S., and carried unanimously, "That the best thanks of the Society be given to C. J. H. Allen, Esq.; R. J. Farrant, Esq.; Dr. A. Farre; and John Millar, Esq.; for having acted as Trustees of the Funds of the Society, and for all the trouble they have so kindly incurred respecting the same."

The following papers were announced to be read at the next meeting:—"On the Fibres of the Crystalline Lens," by Geo. Gulliver, Esq., F.R.S.; and "On Zoospores of Crustacea," by Alfred Sanders, Esq.

Donations to the Library and Cabinet, February 10, 1869:—

	From
Land and Water	*Editor.*
Scientific Opinion	*Editor.*
Society of Arts' Journal	*Society.*
Journal of the Linnean Society	*Society.*
The Student	*Publisher.*
Royal Society's Catalogue. Vol. II.	*Society.*
Preliminary Report of the Dredging Operations of H.M. Ship 'Lightning,' by Dr. Carpenter and Dr. W. Thompson	*Dr. Carpenter.*

* Those with the asterisk placed before their names are new members.

Donations to the Library and Cabinet—continued.	From
United States' Patent Office Reports for 1866. Three Vols. ..	*U. S. Government.*
Verbreitung und Einfluss des Mikroskopischen in Sud- und Nord- Amerika, by C. G. Ehrenberg	*Henry Lee, Esq.*
An Improved Pseudoscopic Microscope	*Chas. Heisch, Esq.*
Some Casts of Diatoms	*Dr. Maddox.*
A Slide of *Trombidium tinctorium*	*Mr. Leggett.*
Nine Slides of *Ophiocoma granulata*, &c.	*Dr. Carpenter.*
114 Slides of Free Nematoids	*Dr. C. Bastian.*

WALTER W. REEVES,
Librarian, &c.

The following gentlemen were duly elected Fellows of the Society:—

Robert Turtle Pigott, Esq.
Herbert Campbell Moss, Esq.

WALTER W. REEVES,
Assist. Secretary.

QUEKETT MICROSCOPICAL CLUB.

At the forty-first ordinary meeting, held at University College, January 22nd, Arthur E. Durham, Esq., F.L.S., &c., President, in the chair,—ten new members were elected, and ten gentlemen were proposed for membership; several presents to the cabinet and library were also announced, and duly acknowledged. The President informed the meeting of the great amount of success which had attended the establishment of the Microscopical Society of Liverpool; it had already been joined by a large number of influential scientific gentlemen residing in that district, and gave promise of becoming as great a success in its way as the Quekett Microscopical Club had been in London. He had great pleasure in announcing that at its January meeting their Secretary, Mr. W. M. Bywater, had been elected the first honorary member. The Hon. Secretary for foreign correspondence, Mr. M. C. Cooke, communicated the intelligence of the establishment of the Chicago (Illinois) Microscopical Club, upon the basis of the Quekett Microscopical Club. He also intimated that his class for the study of microscopical fungi would assemble for the first time on the following Tuesday evening, in a room kindly lent for the purpose by Mr. Wheldon.

A paper by Mr. Samuel Holmes, "On a new Form of Binocular Microscope," was read by Mr. George; it gave an account of some experiments on stereoscopic vision made in 1858, but which were set aside on the appearance of Mr. Wenham's binocular. The desirability of obtaining if possible an equal amount of light in each tube, as well as an equal angle of vision, had since led the author to renew his attention to the subject, and the paper in question described the plan by which it was proposed to effect these results. A specimen of the optical arrangements to be used, and a diagram showing its method of application, were submitted to the meeting; and after a few remarks by Messrs. Bockett and Leighton, unanimous votes of thanks were passed to the author and the reader of the paper. Mr. W. T. Suffolk then read a paper "On some of the means of delineating Microscopical

Objects," in which, after describing the processes of photography and drawing, and enumerating the contrivances in common use for the purpose, he threw out a number of valuable hints as to the best methods of procedure. An interesting discussion followed, in which Messrs. Bockett, R. H. Johnson, Ruffle, T. C. White, McIntire, Marks, Dr. Matthews, and the President took part, and a hearty vote of thanks was accorded to Mr. Suffolk for his paper. The President announced that the annual soirée of the club would be held on March 12th, at University College, the council of which had in the most liberal and courteous manner placed the building at the disposal of the committee for that occasion, and had further expressed their willingness to afford every facility for carrying out the necessary arrangements. The proceedings terminated with a conversazione, at which many objects of interest were exhibited. The last of the winter series of conversational meetings was held at University College, on February 12th, when, as on previous occasions, there was a numerous attendance of members and their friends, and many objects of special interest were exhibited.

[Report supplied by Mr. R. T. Lewis.]

Manchester Circulating Microscopic Cabinet Society.

Annual Meeting, held 12th January, 1869, at the house of Mr. T. Armstrong, 88, Deansgate, Manchester. Present—Mr. Horne, Mr. T. Armstrong, Mr. Aylward, Mr. H. Armstrong, Mr. Nash, and Mr. Hope. Also, Mr. T. Hyde, Mr. T. H. Hope, and Mr. G. B. Armstrong, as friends. Mr. T. Armstrong in the chair.

Minutes of previous meeting read and confirmed.

The Cash Account for the past year was read by the Treasurer, examined, and passed.

Tenders for 'Microscopical Journal.'—Mr. Armstrong explained that only two tenders had been sent in, and those were in the hands of Mr. Aylward, who had omitted to bring them to the meeting. Agreed that the tenderers (Mr. T. Armstrong and Mr. Hope) settle this matter between them.

Election of Officers.—For the office of President, Mr. Horne and Mr. T. Armstrong were proposed, and the former was elected by a majority of 1.

Treasurer.—Mr. T. Armstrong and Mr. Nash were proposed for this office, and the former was elected by a majority of 2.

Secretary.—Mr. Nash and Mr. Hope were proposed, and the latter was elected by a majority of 2.

Subject for next Meeting.—Proposed by Mr. Hope, and seconded by Mr. T. Armstrong, that the subject for the next quarterly meeting be "Crystals." Carried unanimously.—The next meeting to take place on the 13th April, 1869, place of meeting to be named afterwards.—Proposed by Mr. T. Armstrong, and seconded by Mr. Aylward, that the quarterly meetings in future commence at seven o'clock instead of eight. Carried unanimously.

Journal for 1869.—Proposed by Mr. T. Armstrong, and seconded

by Mr. Nash, that the 'Quarterly Journal of Microscopical Science' be discontinued, and the new journal, entitled 'The Monthly Microscopical Journal,' be taken instead. Carried unanimously.

The rest of the evening was spent very pleasantly in viewing the various parts of the "Spider," of which all members present contributed slides—those of Mr. Horne and Mr. T. Armstrong being exceedingly good. This meeting terminated at 10.5 p.m.

THOMAS ARMSTRONG,
Chairman.

MICROSCOPICAL SECTION OF THE MANCHESTER LOWER MOSELEY STREET NATURAL HISTORY SOCIETY.

Minutes of Meeting, 11th January, 1869. Mr. Chaffers presiding.—The minutes of last meeting were read and confirmed.

The following members brought their microscopes:—Messrs. Armstrong, Hope, Chaffers, Hyde, Nash, Wrigley, Jackson, and Wilmot.

The following objects, amongst others, were exhibited:—

Mr. Hope, *Spiracle of Dytiscus, Soldier Beetle, Scale of Eel*, &c.

Mr. Nash, *Foraminifera, Scale of Flying Fish*, &c.

Mr. Armstrong, *Whisker of Walrus, Eggs of House-fly, Tendon from Human Hand, Deep-Sea Soundings*, &c.

Mr. Jackson, *Pith of Briar, Hard Fern Spore*, &c.

Mr. Chaffers, *Parasite of Pike, Tongue of Limpet, Tongue of Moth, Ear of White Mouse*, &c.

Mr. Wilmot, *Tongue of L. Pereger, Parasite of Pike, Lung of Freshwater Mussel, Spores of Osmunda regalis.*

The following contributions were added to the Society's cabinet:—

Mr. Armstrong, *Foot and Spiracle of Caterpillar, and Tracheæ of Silkworm.*

Mr. Jackson, *Spores of Blechnum Boreale, Pith of Wild Briar.*

Mr. Hyde, *Pith of Elder, Section of Pine-seed.*

Mr. Chaffers, *Spiracle of Moth, Fore-Legs of Wasp, and Head of Sheep-Tick.*

Minutes of Meeting, 8th February. Mr. Chaffers presiding.—Minutes of previous meeting were read and confirmed.

Moved, seconded, and carried, that the section take in the 'Microscopical Journal' for this year.

It was agreed that each member should, at the next meeting, bring a slide or slides of the *Cockroach* or *Cricket*, with observations thereupon.

Mr. Armstrong to read a paper at the meeting, 8th March, subject left to himself.

Remainder of evening spent by Mr. Aylward and Mr. Chaffers, each dissecting tongue of *Helix aspersa.*

Mr. Jackson dissecting *Dytiscus Beetle.*

Mr. Armstrong exhibiting a series of slides, the Garden Spider and its dissections.

Mr. Wilmot exhibiting parasites from *Argulus foliaceus*.

Several presentations were made to the Society's Cabinet by Messrs. Armstrong, Hope, Aylward, and Hyde.

Brighton and Sussex Natural History Society.

February 11th, the President, Mr. Glaisyer, in the chair.—A discussion on the nature and origin of flint; after which, a series of objects illustrative of the different ways in which silex or flint is met with in nature, was shown under microscopes by the following gentlemen:—

Mr. R. Smith exhibited sections of flint, containing *Xanthidia*, corals, sponge spicules, and dendritic oxides, commonly called *Moss agates*; and chert containing *Pixidularia* and other organisms.

Mr. J. Dennant showed a mass of silex found among the ashes of a wheat-stack destroyed by fire, and siliceous cuticles of wheat, Indian corn, and Equisetum.

Mr. R. Glaisyer exhibited *Polycistina* from Barbadoes deposit; stellate hairs of *Deutzia scabra* and *D. gracilis*, on young leaves, in which the scales were packed close together; disintegrated glass, showing markings similar to those on some diatoms and sections of silicified coniferous wood.

Mr. Hennah showed sections of flint containing a sponge, *Siphonia pyriformis*, and seed-vessels; sections of quartz through the optic axis, by which the coloured rings were shown; and artificial diatoms obtained from a gaseous condition of silex by the process described by Max Schultze, in which markings similar to those on real diatoms were seen. These objects were exhibited under one of R. and J. Beck's new large microscopes, with concentric rotating stage and iris diaphragm, which was kindly lent by Mr. J. Beck for the occasion. There was an especial interest attached to the iris diaphragm, as it was the invention of Mr. J. Brown, a member of the Society.

Mr. T. Cooper exhibited recent and fossil sponge spicules and gemmules.

Mr. Wonfor showed Foraminifera in flint; sponge spicules, Foraminifera, and portions of corals, found in a hollow flint nodule; and Möller's Diatom Type Slide, very kindly lent for the occasion by Mr. T. Curteis, of Holborn, and which was pronounced a marvellous example of human ingenuity, arrangement, and clean preparation.

Bristol Microscopical Society.

Wednesday, 20th Jan., 1869.

Mr. W. J. Fedden, Vice-President, in the chair.—The minutes of the last meeting having been read and confirmed, Mr. W. L. Carpenter, B.A., B.Sc., presented and described to the Society some objects sent for the Society's cabinet by Dr. Carpenter, of London. These consisted chiefly of specimens obtained by Dr. Carpenter in his recent dredging expedition.

Wednesday, February 17th.

The minutes of the previous meeting were read and confirmed.

Mr. T. Graham Ponton, F.Z.S., Hon. Secretary, then read a paper "On the Methods and Standards of Microscopical Measurement."

Aberdeen Microscopical Society.

The Annual Meeting of this Society was held in the Grammar School, on January 12th, when the following gentlemen were elected office-bearers for the ensuing year. *President*—Professor Dickie. *Vice-Presidents*—Professor Nicol and Mr. A. D. Milne. *Treasurer*—Mr. George Walker. *Secretary*—Rev. Alex. Beverly. *Curators*—Mr. A. Clark and Mr. R. Leys. *Council*—Dr. Ogilvie, Dr. Gordon, Mr. J. Roy, and Mr. R. Ferguson. The proceedings of this Society during the past Session have been of considerable interest and value.*

Old Change Microscopical Society.

At the monthly meeting held February 19th, the President, Chas. J. Leaf, Esq., F.L.S., in the chair,—Mr. M. C. Cooke, Vice-President of the Quekett Microscopical Club, delivered a very valuable lecture on "Fungi," which he illustrated most ably by means of upwards of sixty drawings, and by numerous mounted slides and specimens.

The thanks of the Society were unanimously awarded to Mr. Cooke, for his interesting and instructive lecture.

A paper was also read by Mr. C. D. Richardson, on "Floscularians," being a continuation of one contributed at the last meeting of the Society.

The thanks of the Society were voted to the Quekett Microscopical Club, Major Owen, F.L.S., and Dr. Wallich, F.R.S., for the 'Quekett Journal' and various original papers.

CORRESPONDENCE.

Wet or Dry Objectives.

To the Editor of the 'Monthly Microscopical Journal.'

February.

Sir,—At the October Meeting of the Royal Microscopical Society last year, one of the Secretaries, Mr. Hogg, announced—firstly, the presentation of a series of photo-micrographs by Dr. Woodward, taken from Nobert's test-lines; and, secondly, that he had prevailed on his friend, Mr. John Mayall, jun., to undertake a careful examination of those photographs, with a view to a report on their value and truthfulness. At the same meeting this report was read by the author,

* From 'British Medical Journal.'

and now, after four months, it comes before the Fellows in your last issue, but modified and altered almost beyond recognition, as the 'Transaction' of last October.

Mr. Mayall's abilities as a photographer cannot be questioned; therefore, when the Fellows present at the reading of his paper heard the detailed analysis of the photo-micrographs, they must have felt that beyond this there was no appeal; not so with his incidental remarks on the comparative qualities of various objectives: and, indeed, the accuracy of these remarks was immediately challenged.

It is, then, with regret and disappointment that I now see the valuable, because authoritative, portions of the paper suppressed, while the secondary or incidental parts of the original memoir are amplified, and the contained opinions somewhat rashly enforced.

On the comparative merits of high powers—wet and dry—and the absolute superiority of either, there are not probably in England a dozen microscopists thoroughly qualified to decide. The arbiter must have had lengthened experience with all kinds of objects, and every variety of illumination; but as Mr. Mayall, jun., can scarcely have had the former, and, regarding methods of illumination, seems to content himself with one—the oblique, I should beg your readers to suspend judgment in his suit of Immersion *versus* Dry Objectives until competent authority gives a decisive verdict. Perhaps the Council of the Royal Microscopical Society may be induced to appoint a sub-committee to inquire into this important matter.

To Mr. Mayall should be given every credit for good intentions. His grief can be imagined when forced by a bitter sense of duty to denounce—mildly and with all scientific propriety, but still to denounce—our microscopes and all who use them. But let him take heart; our English opticians are again taking up this old novelty—the immersion system; and if found really serviceable, no doubt it will be adopted. In the meantime, and at the worst, our glasses may pass as very respectable mediocrities. They resolve the finest tests, and are actually preferred by the American photographers for the most exquisite micrographs ever taken, of the finest lines ever seen.

Without having more than an average experience and skill with the microscope, even I—a mere "amateur with a wonderful $\frac{1}{4}$th"—can readily discover facts in direct contradiction to Mr. Mayall's observations. Unlike that gentleman, I meet no difficulty whatever in finding evidence that the resolution of lined objects is almost entirely a question of large angle in the objective; that comparatively low powers (such as $\frac{1}{4}$ths and $\frac{1}{6}$ths), with apertures above 130°, show the fine longitudinal markings on *S. gemma*, and that higher powers of similar angles fully verify the results. The statement that immersion-lenses are in effect reduced to a certain small angle, beyond which a law of refraction forbids them to work, seems entirely negatived by the fact that one of these objectives bore in my presence the very greatest possible obliquity in the light, without giving the slightest indication of black-ground illumination,—an effect easily produced with any glass of angle less than 140°.

Leaving the useless, harmless Diatomaniacs out of the question, what practical microscopist will be content with a kind of objective which (according to its advocate) would seem to bear with advantage but one kind of test, one kind of illumination, and both these of rare occasional use to original investigators?

The objection to the Podura-scale as being a test open to "flattery" is puerile. If the ordinary large scale be found too coarse for extra high powers, there are small scales with delicate markings never yet well made out; and many other definition-tests for axial illumination, the existence or use of which is (by Mr. Mayall) strangely, but perhaps not unaccountably, ignored.

I am, Sir, your faithful servant,

Cornhill. H. Davis.

OBITUARY.

The late Mr. Thomas Brightwell.

Died at his residence, Surrey Street, Norwich, on the 17th November, 1868, Thomas Brightwell, F.L.S., aged 80.—Of the respect and esteem felt for him by his fellow-citizens it is not necessary here to speak; but a few words in memory of so ardent a student of the microscope may interest many to whom his name will be familiar. Always an attentive observer in all branches of Natural History, from the time that the improvements in the microscope placed in his hands a first-rate achromatic instrument, Mr. Brightwell devoted himself largely to its use, and more especially applied himself to the study of the *Diatomaceæ*. In the earlier volumes of the 'Microscopical Journal' will be found his papers on the Genera *Triceratium Chætoceras*, &c., and also on the *Noctilucæ*, from which he obtained many interesting marine forms. About ten years ago symptoms of cataract in both eyes enforced the abandonment of his favourite pursuit. His cabinets then contained about 1500 slides; some illustrating his own papers, others presented to him by Dr. Gregory, Dr. Wallich, Dr. Hooker, from the Himalayas, besides one fine series to represent the British species, and another the forms found in guano. Mr. Brightwell was anxious that the slides from which his own papers were written should be always available for examination, and he therefore determined to give his instrument and collection to the few friends who, under the title of the 'Norwich Microscopical Society,' had been in the habit of meeting with him monthly at one another's houses. The gift was thankfully received, and the necessary arrangements for its safe custody soon made. The Society has since had the pleasure of lending a series of nearly three dozen slides to Dr. Eulenstein, of Dresden, for reference in his forthcoming work on *Diatomaceæ*. Thanks to an operation performed by Mr. Bowman, Mr. Brightwell recovered his sight. Prudence prevented any resumption of micro-

scopic study, but he was able at the meetings of the Society to examine any novelty. Till within a month of his death his erect form and active step betokened more the man of 60 than 80; but old age suddenly asserted its power. His strength forsook him, and, fortunately without suffering, he peacefully departed.*

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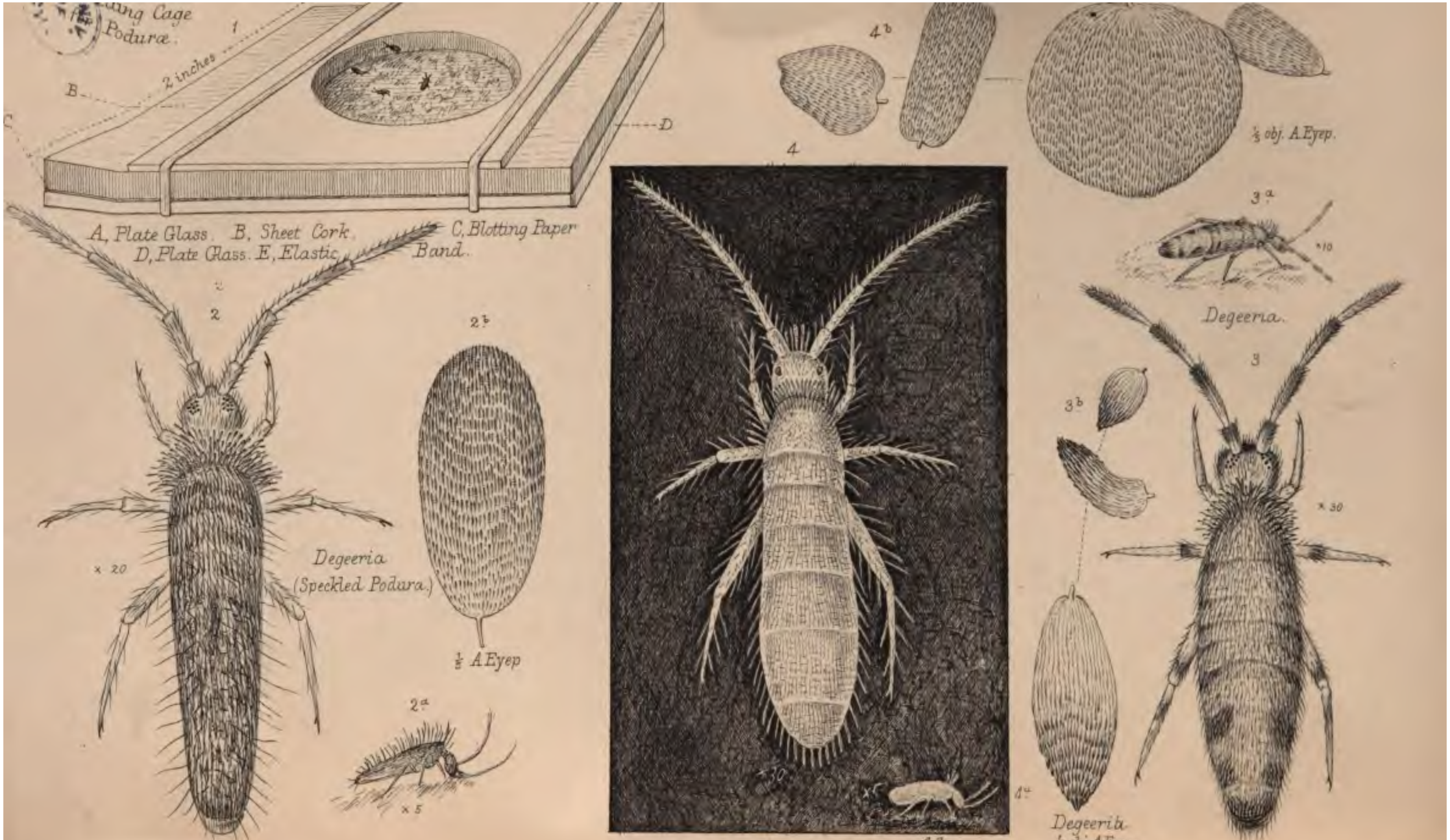
* Furnished by our Norwich correspondent.



Templetonia.

THE

MONTHLY MICROSCOPICAL JOURNAL.

APRIL 1, 1869.

I.—*Notes on the Scale-bearing Poduræ.*

By S. J. McIntire, F.R.M.S.

(*Read before the* Royal Microscopical Society, *January* 13, 1869.)

The promise once made to this Society, in a paper by the late Mr. R. Beck, on the Scale of *Lepidocyrtus*, to describe certain interesting species of *Podura* other than that from which the celebrated "test" scales are obtained, induces me to endeavour to fill up this much-to-be-lamented blank, since the subject of poduræ-scales has been an interesting one to the microscopical observer for many years. I detail my own experiences in the search after them, but at the same time I acknowledge the great assistance I have derived from the occasional perusal, when I have had the opportunity, of Sir John Lubbock's admirable papers on the *Thysanura*, in the Transactions of the Linnean Society, and will

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EXPLANATION OF PLATES VII. & VIII.

Plate VII.

Fig. 1.—Breeding-cage for Poduræ.
A. Plate-glass.
B. Sheet-cork.
C. Blotting-paper.
D. Plate-glass.
EE. Elastic Bands.
„ 2.—Degeeria ("Speckled Podura") × 15 diameters.
2*a*. Side-view of the same, less magnified.
2*b*. Scale of same × 250.
„ 3.—Degeeria (unnamed, by S. J. M.) × 25.
3*a*. Side-view of the same, less magnified.
3*b*. Group of scales from same × 250.
„ 4.—Templetonia (Nitida?) × 20.
4*a*. Side-view of same, less magnified.
4*b*. Group of scales from same × 250.

Plate VIII.

„ 5.—Macrotoma Plumbea × 20.
5*a*. Side-view of same.
5*b*. Group of scales from same × 250.
„ 6.—Lepidocyrtus curvicollis × 20.
6*a*. Dorsal aspect.
6*b*. Lateral view of same.
6*c*. Two scales from same × 250.

take the liberty of referring to these notes pretty freely in the few imperfect remarks I have to make.

To begin—it may be well, so far as it relates to the subject, to give a brief sketch of the classification he adopts.

The *Thysanura* are primarily divided into *Lepismidæ*, whose bodies terminate in setæ, and the *Poduridæ*, whose bodies for the most part terminate in a bifid tail, which is kept folded under the body when the insect is at rest.

The *Poduridæ* again are divided into *Smynthuridæ*, having the body more or less globular; the *Poduridæ*, having the body linear; and the *Lipuridæ*, whose bodies are linear; but the bifid tail is rudimentary, or entirely absent.

The second of these divisions is that to which all the creatures I have now to bring under notice belong, and it is divided into eight genera:—

1. *Orchesella:* the antennæ of which are long and six-jointed; the eyes, six on each side, arranged in the form of the letter S; and no species that I have yet found is furnished with scales.

2. *Degeeria:* the antennæ of which are four-jointed; the body more or less spindle-shaped; the eyes, eight on each side of the head, sometimes clothed with scales, and sometimes with hairs.

3. *Templetonia:* the antennæ five-jointed, with the terminal joint ringed; and, in the single species which has come under my observation, furnished with scales.

4. *Isotoma:* having simple hairs, and no scales; antennæ four-jointed; and eyes, seven on each side of the head, in the form of an S.

5. *Macrotoma:* having very long, straight, four-jointed antennæ, the two terminal joints being ringed; eyes, six on each side; and an abundance of scales.

6. *Lepidocyrtus:* antennæ long, four-jointed; eyes, said to be eight on each side (but I have failed to count them); an abundance of scales; and a peculiar habit of carrying the head, not easily described, but, when once seen, remembered without difficulty.

7. *Poduræ:* hairs simple; no scales; eyes, eight on each side; antennæ four-jointed; saltatory appendage of moderate length.

8. *Achorutes:* antennæ short, four-jointed; eyes, eight on each side; saltatory appendage quite short.

It will thus be seen that my remarks on the Scale-bearing *Poduræ* will be confined to the genera *Degeeria*, *Templetonia*, *Macrotoma*, and *Lepidocyrtus*.

Originally my efforts were limited to procuring specimens of the respective scales, but soon my attention was diverted to the far more interesting employment of studying the habits of the insects from which I obtained them. To compass this end, it was necessary to provide some means of keeping the creatures alive and in health for prolonged periods, and to permit the employment of *microscopic* power upon them at any time meanwhile, without

disturbing them. Aided in my experiments by the suggestions of kind friends, I at last completely overcame all difficulties in manufacturing the requisite pieces of apparatus; specimens of which I exhibit, and a glance at them will explain the manner in which the result is attained. They each consist of a piece of the best sheet cork for lining entomological boxes, with a hole punched out of the centre; a pad of blotting-paper,* to form the bottom of the cell, and to be damped with clean water when necessary; plate-glass top and bottom, and india-rubber rings to bind the whole together.

I have found two species of *Degeeria* which are scale-bearing. The first of these † I have elsewhere called "Speckled," that being the term which seems to convey the best idea of its appearance under the microscope. It is about $\frac{1}{10}$th of an inch long, and Sir John Lubbock's figure of *Degeeria lanuginosa* bears a strong resemblance to it, but I doubt if it be the same. It is furnished, especially near the head, with an abundance of clubbed hairs, as well as scales. The scales are of various depths of tint, ranging from pure white to dark brown; and the dark ones are for the most part situated all along the median line of the back and at the posterior margins of the segments.‡ The antennæ are very long and slender, and so are the legs. The eyes are black, and conspicuous from their size and arrangement. In the months of May, June, and July chiefly the eggs are laid; they are scattered about singly over a comparatively wide space, and for some days before bursting the eyes of the contained young ones are visible through the investing pellicle. The insect is not much given to leaping, though its powers in this way, when alarmed, are considerable, and it runs with considerable speed when it is on the move from place to place. I have met with it only in two localities—both of these in London; and I believe it to be uncommon. In confinement it eats oatmeal, but sparingly, and ultimately pines away. In its natural state, I *suspect* it feeds on dry decaying wood. The structure of the scale I have already attempted to describe in 'Science Gossip.'§

The second species of Scale-bearing *Degeeria* bears a strong resemblance in form to the species of *Degeeria* which are not scale-bearing. It is of a stone-colour, and the hinder segments, especially the sixth, are ornamented with patches of a dark-brown or black, disposed with regularity on each side of the median line. In some individuals these patches are larger and more continuous than in others. The insect is active, and runs rather than leaps, and while running

* Pink blotting-paper seems to answer best, since it readily shows when the cell is getting too dry, and the colour is not in any way detrimental to the health of the poduræ. Four inches by two inches is a very convenient size, the cell itself being an ellipse of 1¼ inch in the long diameter.

† The arrangement of its eyes, and its unusually long limbs, may induce future observers to regard it as the type of a distinct genus.

‡ Sometimes these dark scales are so profusely distributed, that it is not easy to distinguish the segments of the body.

§ Vol. iii., p. 53.

it keeps its body very close to the ground. It is about $\frac{1}{15}$th to $\frac{1}{20}$th of an inch in length; the eyes are placed either upon or immediately adjoining a dark band which runs round the front of the head at the base of the antennæ, and are eight on each side, arranged in nearly parallel rows of four in each. Sir John Lubbock's description of *Degeeria nigromacula* seems to come very near it, but that author does not say if the possession of scales is a feature of the species known as *D. nigromacula*. I have met with it in a greenhouse at Theale, Berkshire; under some boards in a yard in Pimlico; and it has been sent me from two other metropolitan localities. The scales are almost uniformly leaf-shaped, almost *ovate*, the free end forming quite an acute angle, and the other being nearly semicircular. I have found individuals in which the scales were shorter and broader than others.

The only species of *Templetonia* that I have yet found is an exceedingly beautiful creature of pearly whiteness, with brownish-pink reflexions in the shadows, and red eyes and mouth. It inhabits cellars, the roots of plants, and damp earth where the growth of minute fungi is fostered. Although to all appearance this species is very delicate, I have had experience that it can hold its own in the struggle for life most effectually; for, on one occasion, having enclosed a colony of some twenty of them with a similar number of *Lepidocyrti*, I found that the former completely exterminated the latter and all their eggs in less than a month afterwards. In this cell of $1\frac{1}{4}$ inch in diameter and less than $\frac{1}{4}$ of an inch deep they multiplied abundantly, and in the course of a couple of months had increased to somewhere about 300. I never before or since had so beautiful and interesting a sight to display under the microscope. Now they seemed to play with each other, caressing one another's heads and antennæ; then they would quarrel, the weakest of course retreating precipitately, and general confusion would result, owing to the crowded state of the population. By-and-bye the disturbance would be over, and they might be seen industriously searching for and eating the fragments of crushed malt which I at intervals introduced as food.

The eggs of this species are scattered about singly, and the young hatch out in about a week or ten days afterwards. The scales are very beautiful, but owing to their great convexity, like the petals of a rose-blossom, it is difficult to get them properly spread out in order to see them satisfactorily under high powers. The corrugations follow each other almost continuously, so that the scale seems to be pleated or ribbed.

There are several species of *Macrotoma*, differing chiefly in point of size and colour. Two species that I have seen have leaden reflexions from their bodies, and a third is of a jet black. Full-grown individuals are among the largest of the *Poduræ*, reaching to the length of nearly $\frac{1}{4}$th of an inch, exclusive of the antennæ, which are

in most cases as long as the whole body. They are pretty generally distributed, and their activity is very great, especially as runners; they also leap well, but they resort to this mode of escape comparatively seldom. The scales are peculiar both in their form and marking, and exhibit affinities with *Lepisma* scales, especially the scales of *Petrobius maritimus.* I have found the insects at Theale, and under heaps of brickbats at Brixton, and I have also noticed it about ferneries.

I do not intend saying anything respecting the scale of *Lepidocyrtus,* since our late friend, Mr. Beck, has treated the subject already in an exhaustive manner. The insect, however, is a most interesting creature, and much might be said as to its beauty and its habits; it may with care be kept alive for months. The species from which the "test" scale is obtained is, I think, best described by the name *L. curvicollis,* from its habit of doubling up its head considerably out of the perpendicular position under the thorax; and when in its best condition is a most gorgeous little creature. It lays its eggs at various times all through the summer, in clusters of thirty to eighty, and the young hatch out in about a week. At first they appear to be scaleless, but they frequently cast their skins, and after each operation the tegumentary appendages are found better developed and consequently more beautiful, till at last—at least, I believe so—those large and strongly-marked scales which Richard Beck has delineated so well, make their appearance.

Other species of *Lepidocyrtus* are very minute, and their scales do not, to the best of my knowledge, differ much, if at all, from the smallest of the scales of *L. curvicollis.* One species, which I think is that to which Sir John Lubbock applies the name *L. gibbulus,* has a fringe of cilia at its neck; is rather humped in appearance, though not so much so as *L. curvicollis,* and jerks its antennæ, which are short, somewhat violently as it runs. It is a pretty insect, and its restless activity makes it a very interesting captive. Another species, of which I have as yet only found two examples, is of a cream colour, very active, only a little larger than *L. gibbulus,* which it imitates in jerking its antennæ; but it imitates the habit of *Degeeria* in keeping its body low while running. Its scales are extremely difficult to resolve, and of no particular beauty.

The few remarks which remain for me to make apply generally to the species to which I have alluded.

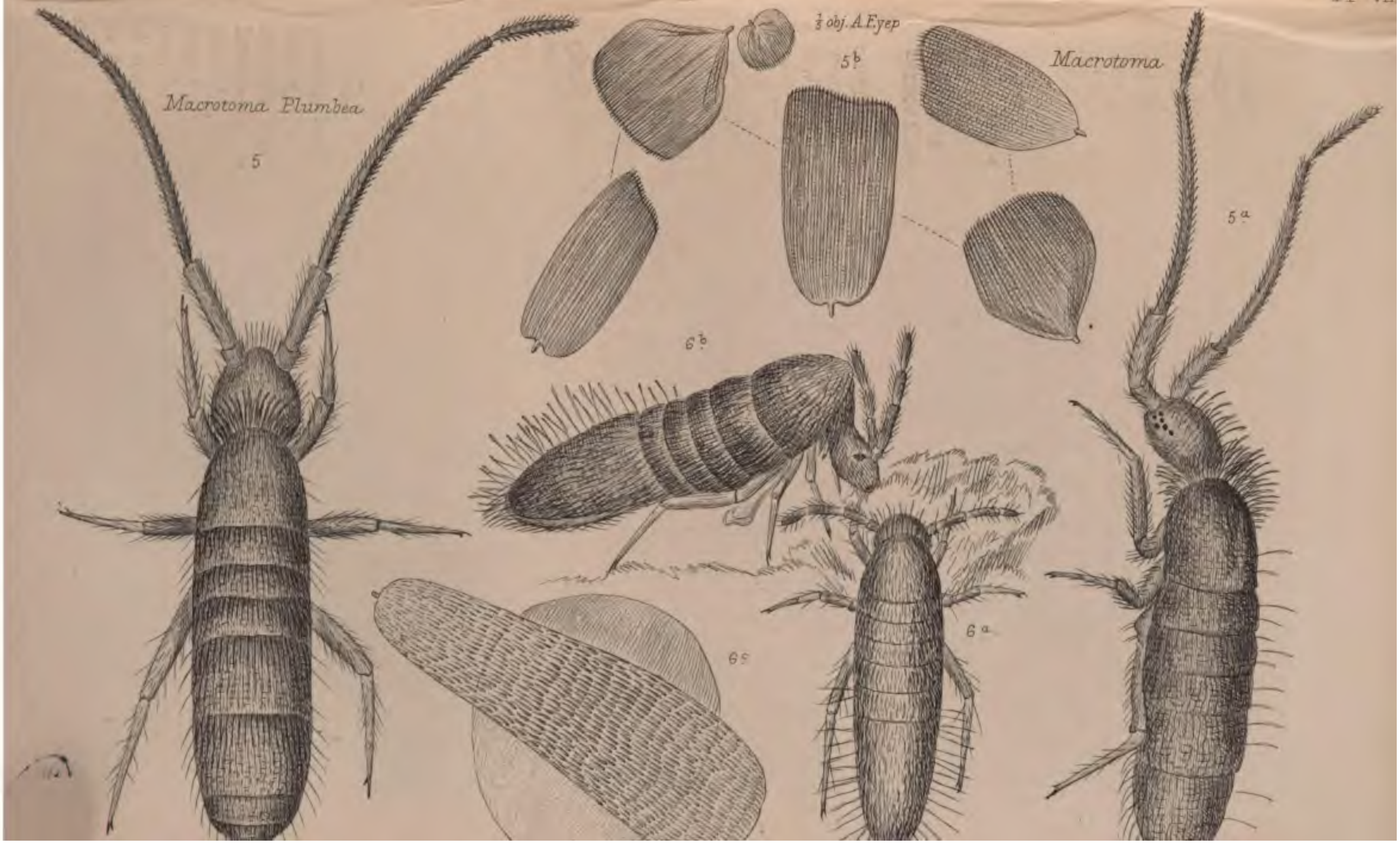
Mr. Beck has told us how to obtain the scales; and if scales only are wanted, his plan is a good one. Some persons, however, still adhere to the old plan recommended in Dr. Carpenter's work, by means of a test-tube and a glass slip. I prefer obtaining them thus: After capturing the insect by means of a tube and a camel's hair pencil, I let it remain for some days in one of the breeding-cages, into which I alway transfer the newly-caught poduræ, until it has changed its skin: then I stupefy it with chloroform, and drop it

out into a thin glass-cover (previously cleaned), and with a very clean needle-point roll it backwards and forwards upon the glass till sufficient scales are removed. A *very light* pressure is indispensable, so as not to squeeze out any of the insect's fluids.

A vigilant search in the localities likely to be frequented by poduræ is the only means of obtaining the insects. The walls and floor of cellars, the under-side of pieces of damp wood and old mouldy bungs and corks lying upon the floor, are their special haunts in houses. Out of doors they are to be sought under stones, especially brick-bats in heaps of old rubbish, nestling on the roots and bark of decaying trees, scampering about among moss growing in shady and damp situations—and if the search be made in green-houses, the bottoms of the flower-pots and boxes, the ornamental rock-work of the ferneries, and the brick sides and floor are their most favoured localities. They often occur in quite unexpected places.

After keeping them for some time, I notice that they are prone to eat their dead companions, and also that they are able to renew their antennæ or legs, if injured, with great facility. Thus it will sometimes appear that the antennæ are of different lengths, or, even if they be of the same length, it may be that a joint or two is in course of being replaced. A number of *Lepidocyrti* that I enclosed with an active specimen of *Chelifer Latreillei* this autumn, suffered considerable damage from the claws of that creature; but after the *Chelifer* had appropriated to itself a corner of the cell in which to hybernate, the miserable poduræ recovered from their injuries, and their legs and antennæ all grew again.

The dissection of these insects is extremely difficult, owing partly to their minuteness and partly to the softness of their bodies. Mounting them in spirit and water has, in some cases, afforded me a glimpse of their internal anatomy, but the information I have gained in this direction is extremely small. The distinctive features of the sexes of those genera with which I have had to do (if there be any distinction), for I should not be surprised if it were discovered that both sexes are united in the same individuals, has been to me a great puzzle, and so are the functions of the ventral tube and another external organ between it and the root of the springer. I have seen this ventral tube fulfilling the office of a sucker on a glass surface; and I have frequently observed the insect obtaining from it a fluid wherewith to lubricate and cleanse its limbs. I have watched poduræ of various genera patiently for the last three years, and though vast numbers of eggs have been laid and hatched under my own observation, I have never seen a case of copulation. I have detected traces of tracheæ in the exuviæ of *Lepidocyrtus*, and seen what appear to be spiracles in the genus *Podura;* but it seems to be doubtful, according to Sir John Lubbock's researches, so far as they are published, if tracheal tubes are invariably present.


Macrotoma Plumbea
5
⅓ obj. A Eyep
5b
Macrotoma
5a
6b
6a
6c

II.—*On the Fibres of the Crystalline Lens of Petromyzonini. With a Note on the Æsophagus of the Aye-Aye.*

By GEORGE GULLIVER, F.R.S.

(Communicated by W. H. INCE, F.R.M.S., F.L.S.)

(*Read before the* ROYAL MICROSCOPICAL SOCIETY, *March* 10, 1869.)

AN extensive comparative survey of the fibres of the crystalline lens of vertebrate animals would be likely to afford some interesting and valuable results for zoology and physiology.

I know of no recent observations on the subject. Since the discovery by Brewster of the junction of the edges of these fibres by sinuous or dentated suture, the excellent examples which that philosopher gave of it in fishes were truly accepted as conclusive, so far as it had been examined.

But there are fishes in which the fibres of the lens differ remarkably from those just mentioned as well known in this class, and of which difference a curious illustration is now to be given.

Of the Lamprey (*Petromyzon fluviatilis*), the fibres of the crystalline lens when highly magnified (Fig. 1, p. 211) appear long, flexible, quite smooth, of nearly equal breadth in a great part of their length, and commonly flattened; and being joined together laterally by level and straight sutures, the fibres are very easily separable from each other. Though colourless and transparent, they refract the light so as to present their outlines distinctly; and when spread out in a sufficiently thin layer, recall to mind certain forms of tendinous and elastic tissues; but the lens-fibres neither branch nor anastomose.

As a mere microscopic object the lens of the Lamprey is interesting. The whole of it may be easily teazed out into a congeries of fibres, when its transparency is as completely destroyed as that of glass by pulverization. Thus to the naked eye the parts of the lens torn asunder appear white and opaque; but, when further separated by the aid of needles and viewed by transmitted light under an achromatic object-glass of one-tenth of an inch focal length, the fibres are beautifully hyaline and distinct, many wavy and curled, some nearly or quite straight and parallel, and others sweeping in bold smooth curves among the rest (Fig. 1, showing fibres of the prevailing size). Under a lower magnifying power, the aggregated and separated fibres remind one of locks of human hair thrown carelessly on a flat surface.

"In fishes," says Johannes Müller, "the internal laminæ of the lens have an extraordinary hardness, almost like that of horn." But though the inner part of the lens of the Lamprey is harder than the external part, there is by no means so much difference in this

respect as in most osseous fishes. It is difficult, *e. g.*, to teaze out the fibres in the centre of the lens of *Anguilla acutirostris*, but very easy to do so in the same part of *Petromyzon fluviatilis;* and these two fishes are mentioned because I have often compared them as regards this point. Of the central part of the lens of the Lamprey, the fibres appear shorter, as might be expected, than those at its circumference; and some of the central fibres, especially at the ends where they converge to the poles of the lens, are slightly jagged or sinuous at the edges, contrasting thus with the smooth-edged fibres of which by far the greater part of the lens is composed.

The diameter of the fibres about their middle is nearly equal; the smallest measure about $\frac{1}{8000}$th, and the largest $\frac{1}{4500}$th, while the prevailing diameter is $\frac{1}{6400}$th of an inch; and the difference in the measurements would probably have been less had many bundles of the fibres been seen all lying fairly together on their flat surfaces. When the edge or thinner side presented well, it was found to be about $\frac{1}{12000}$th of an inch thick.

The lens-fibres of the adult Lamprey are but little affected by various re-agents which act energetically on many other animal tissues. The lens-fibres retain their characters when treated either with strong acetic, sulphurous, strong nitric, dilute muriatic, or weak chromic acid; but these fibres become more wavy and curled in acetic acid, and the same too in nitric acid, with the addition of a faint yellow tinge; weak tannic acid clumps them together; they become but slightly fainter with a solution either of caustic soda or ammonia; are but little affected by magenta and carmine; dyed yellow individually, orange-coloured in mass, and their edges made plainer by iodine; and little changed by alcohol or sublimate. The immediate effects only of the forementioned re-agents were noticed on portions of the fibres separated under a deep object-glass. When boiled in water the lens becomes opaque, and its fibres may then be seen converging to points at its opposite poles; in boiled fragments the fibres appear somewhat thickened and their hyaline character diminished (Fig. 2, from portions of the thickest fibres).

Though the chemical properties of the lens are not very striking, their physical specialities are so beautifully distinct that they will probably be a good addition to the many examples now known of the value of several intimate or elementary structures of animals as diagnostic characters in systematic zoology. Upwards of a quarter of a century has passed since I proved, from a very extensive series of observations and in opposition to the then prevailing doctrine, that the structure of the red corpuscles of the blood affords a central diagnostic character between two great divisions—Pyrenæmata and Apyrenæmata—of the vertebrate sub-kingdom; and, in continuation of the same researches, it was shown that either the size or form of those corpuscles was sufficient alone to distinguish

certain families or species from other allied families or species.* To the same effect also were the results of my extension of the inquiry to cell-characters in plants.† "Inherent specific differences," says an eminent physiologist, "are to be demonstrated in the component cells of species as distinctly as in the entire organism; and the more minutely investigation is carried, the more remarkable do these differences appear, and the more numerous do they become."‡ Even so. And the early and important labours in this direction of the late John Quekett, if not lost to science, are too often ignored in our books of comparative anatomy.

Finally, it results from the present observations that positive differences exist between the lens-fibres of some Cyclostomi and the lens-fibres of many Teleostomi. But the precise value of these characters in systematic ichthyology remains to be determined by further observations.

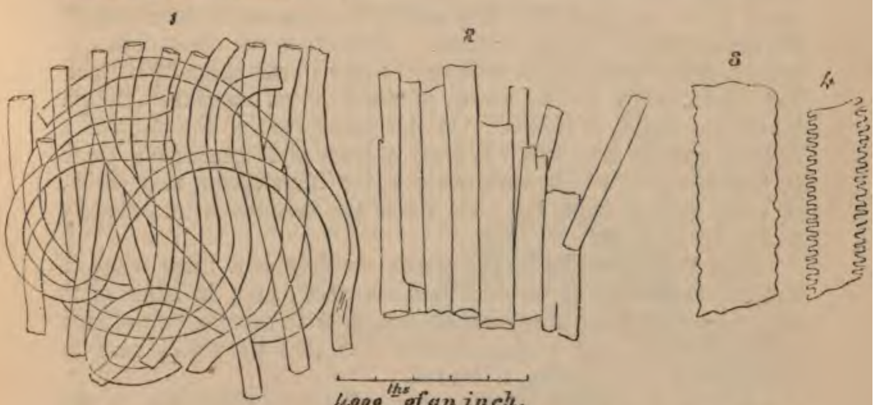


FIG. 1.—Portions of lens-fibres of Petromyzon fluviatilis; the fibres $\frac{1}{6400}$th of an inch in diameter, which is the most common and average size.
„ 2.—The same from a lens which had been boiled in water.
„ 3.—Bit of lens-fibre of Anguilla acutirostris; diameter of the fibre $\frac{1}{2000}$th of an inch, being the average size.
„ 4.—The same of Esox Lucius; the fibre $\frac{1}{2900}$th of an inch in diameter.

CANTERBURY, *Jan.* 30, 1869.

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* Rodentia may be distinguished by the sheath of striped muscular fibre on the lower part of the æsophagus from Quadrumana and some other orders; and in the dissections of the Aye-Aye (*Chiromys madagascariensis*) it is to be regretted that it was not compared in this respect with these two orders to which zoologists have assigned this singular animal. But since this note was printed, I have examined the æsophagus of the Aye-Aye, which agrees with that of Quadrumana, as will be particularly described in the Proceedings of the Zoological Society.

† 'Popular Science Review,' iv., 568.

‡ Professor Beale, 'Trans. Microscop. Soc.,' 1864, N. S., xii., 33.

III.—*Two New Forms of Selenite Stages.*

By Frederick Blankley, F.R.M.S.

Plate IX.

(*Read before the* Royal Microscopical Society, *March* 10, 1869.)

I have much pleasure in submitting to the Fellows of this Society two new forms of Selenite Stages, which I hope may assist our researches in that beautiful and fascinating study—the study of polarized light.

As some objects are affected more by one colour selenite than another, I found it desirable to view each object with different films, in order to observe under which colour the structure could be seen to the best advantage.

In placing the different selenites under the object, it occurred to me that much time and trouble would be saved if the selenites could be so arranged that they might be removed without taking the object out of the field or focus. This led to the construction of the Sliding-stage, which consists of a small brass stage $3\frac{1}{4}$ in. long and $1\frac{1}{2}$ in. wide, in the centre of which is an aperture through which the object is viewed. On the under part of the stage is a dovetail groove, into which is fitted a brass slide containing three or four selenites, which work freely as the investigator may desire. A small spring, stops the slide when the selenite is immediately under the aperture.

The Compound Selenite Stage consists of a brass stage of similar dimensions to the one just described; and, in addition to the brass slide, has a revolving diaphragm with three selenites, each made to rotate, and a clear aperture, so that the object may be viewed with a single film, if desired.

In this stage, each selenite is much larger than those in the small one, and is marked in quarters, so that the colours obtained may be registered and turned to at any time.

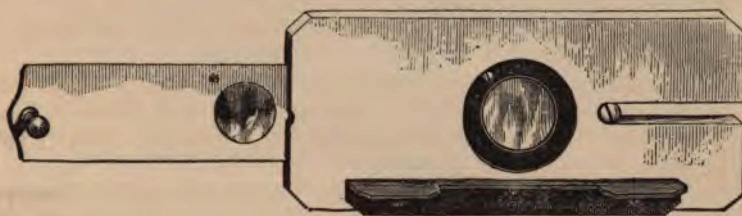
The positive axis of each selenite in the diaphragm is marked coincident with those in the slide.

To increase the variety of colours and tints, rotate each selenite until their cleavage is at the right angle of the positive axis of those on the slide.

By working each film as thus described, twenty-eight colours and tints will be obtained, and can be recorded for future reference.

I think, in using this stage, even a greater number of tints can be seen than the number quoted by Mr. Swift, who is preparing a complete list of changes that can be effected by it.

It is only just to him to say that he has rendered me much assistance by his practical knowledge, and placing the whole of his stock of selenites at my service.



The Sliding Selenite Stage.

The Compound Selenite Stage.

Mr. Blankley's Selenite Stages.

IV.—*Researches on the Constitution and Development of the Ovarian Egg of the Sacculinæ.* By M. J. Gerbe.

The studies which I have pursued for many years at Concarneau, on the development and the metamorphoses of marine animals, have led me to the discovery of a fact which seems to me to clear up a point, still very obscure, in the history of the ovarian egg. In the ovule of a considerable number of species belonging to the divers classes of the animal series, besides the vesicle known to physiologists under the name of *germinative vesicle*, or vesicle of Purkinje, we see a second vesicle, generally smaller, which occupies a position in the egg more or less near to the first vesicle. MM. de Wittich, Siebold, and V. Carus, have pointed it out in the ovules of the common spider; M. Balbiani has discovered it in those of the Myriapods, the Crustacea of the genus *Oniscus*, in *Helix*, the Frogs, in a large number of the Arachnida, &c.; finally, M. Coste had figured it already in 1847, in the primitive ovule of the bird, immediately below the vesicle which forms the centre of the cicatricule. What part, then, does this second vesicle perform? Should we agree with M. Balbiani, in considering it as the true centre of the formation of the germ? May it not, however, be destined to fulfil another function? The question may be thoroughly resolved, it seems to me, by studying the ovule of those singular parasites known under the name of *Sacculinæ* (*Sacculina*, Cavolini; *Peltogaster*, Rathke), which are found adhering to the tail of certain Crustacea, notably *Cancer mœnas*. In these parasites the reproductive organ which represents five-sixths of the entire mass of the animal, contains ovules of all ages, of which the different developmental phases can be traced from their origin to their maturity. Taken towards the central portion of the organ, these ovules, which are only six or eight hundredths of a *millimètre* in diameter, present so different a form from that usually observed in other animals, that it would be difficult to recognize their true character, if we did not see them pass from that state to a more advanced one, which allows of no doubt. They are then formed: (1) of two independent transparent vesicles, of nearly equal size, and nearly touching at one point of their circumference; (2) of a general envelope (the vitelline membrane), which is very delicate, and compressed towards the point where the two vesicles face each other; (3) of a minute quantity of colourless substance, very finely granulated, which separates the two vesicles from the enveloping membrane. The ovule, instead of being globular, is here bi-lobed, and, as it were, composed of two ovules placed back to back, and resembling each other in form and organization.

This first phase is soon succeeded by others which reveal to us the part to be played by the two vesicles. Both these vesicles speedily become enveloped by fine globules, which make their appearance in succession. But whilst round one of the vesicles the globules remain very small, preserve nearly the same volume, and seem to have but a limited multiplication, we see them round the other vesicle present very different sizes, increase by small degrees, and become more abundant as the ovule is nearer to maturity.

That lobe of the egg in which the increase in number and volume of the primitive elements takes place, necessarily undergoes relative modifications. It grows larger to provide room for the materials which multiply in it, in the same way as the vitelline membrane of the bird's egg grows as the yolk becomes developed, and ends by assuming so great a predominance, that the other lobe, whose development has to a certain extent remained stationary, represents only a small eminence on one of the poles of the ovule like that which is produced in the egg of the osseous fishes as a consequence of the condensation of the vitellus.

Such is the appearance presented by the mature ovule of the *Sacculinæ*. As to its organization, it only differs from that of the very small ovules, by the intervention of two distinct elements in unequal proportions. The predominating element, formed of a mass of large and small globules, in the midst of which one of these primitive vesicles is always to be seen, is without doubt the analogue of the yolk of the bird's egg, that is to say, the matter destined to the nutrition of the future embryo; while the circumscribed disc, situated at the periphery of the egg, and composed of very minute granules grouped round the other primitive vesicle, manifestly represents the cicatricule of birds, that is to say, the essential and fundamental portion of the egg, that of which the materials will be directly employed in the formation of the new being. The study of the ovules of the *Sacculinæ*, then, shows us the meaning of the two vesicles which are contained in the eggs of certain species. We may even say that the demonstration is here complete, for we follow the phenomenon through all its phases. One of these vesicles is the centre of the formation of the germinative element, and ought to preserve the name of *germinative vesicle*, under which it is now known; the other is only the centre of formation of the nutritive element.*

* '*Comptes Rendus*,' Feb. 22.

V.—*On the Simple Structure of Compound Leaves.*

By W. R. McNab, M.D., Edin.

The object of this paper is to point out that many of the leaves which Mr. Gorham compares together, to show the transition from the compound to the simple leaf, do not admit of comparison. In comparing the parts of such leaves as the *Rosa canina* and the Oriental Plane, although they seem to present great similarities when placed side by side, yet a knowledge of their development shows that the parts compared are not of the same value. The same may be said of the Horse-chestnut and Sycamore.

There is no morphological distinction between simple and compound leaves. They both arise from the phylloblast in precisely the same manner; and, as the parts of the first order are developing, it is impossible to say whether serration, or lobes, or pinnæ will result. The difference between a simple and a compound leaf is thus not one of type, but a difference in the degree to which the division of parts is carried. The so-called metamorphosed leaves of Mr. Gorham are arrests of development—the differentiation of parts not having been carried to its fullest extent.

If we examine the development of the phylloblast of *Rosa canina*, we find that the upper part, or epiphyll, which develops into the lamina and petiole of ordinary leaves, exhibits that type of development which we find common in the *Rosaceæ*, called the *Basipetal Type*.

The central pinna of this impari-pinnate leaf is the oldest; then the upper pair; while the lower pair nearest the axis is the youngest. These parts are all of the first order—the serration forming the divisions of the second order. In the Rose the parts of the second order develop basipetally.

Contrast this with the Oriental Plane. Here the leaf develops according to the ternate type. Three parts of the first order are developed; the side lobes are parts of the second order, and produced by bifurcation of the side parts of the first order.

I have not examined the development of the Virginian-creeper, so cannot say to what type it belongs; but I suspect it belongs to the Basipetal type. It may therefore admit of comparison with the leaf of the Rose; but, as all the parts of a leaf of the Oriental Plane do not belong to the same order as those of the Rose, they do not admit of a comparison being drawn between them.

The leaf of the Sycamore might be compared with that of the Rose:—the parts of the Sycamore-leaf develop basipetally, and are therefore of the same value as those of the Rose; but the parts of the second order, the serrations, develop in the reverse way, and are

produced basifugally. But the Sycamore cannot be compared with that of the Horse-chestnut, because the Horse-chestnut is in reality a ternate leaf (like the Oriental Plane), the three parts being of the first order, while the rest are produced by bifurcation of the side parts of the first order.

The leaves of Dicotyledonous plants develop in various ways. We may refer them to six types:*—

Type 1. *Basifugal.*—The apex of the leaf the youngest, the base the oldest. When parts of the second order are present, they are also basifugal.

A very good and easily procured example of this type is to be found in the Garden-Pea, as well as all *Leguminosæ* with true pinnate leaves, and several *Umbelliferæ.*

Type 2. *Basipetal.*—The apex of the leaf the oldest, the base the youngest. In this type the parts of the second order may either develop basipetally, as in *Rosa, Potentilla, Poterium,* &c.; or basifugally, as in *Acer Pseudo-Platanus,* and other species of *Acer.*

Type 3. *Divergent.*—The leaves of *Achillea, Pyrethrum,* and other *Compositæ,* have the parts of the first order developing towards both ends from the middle of the leaf; and, when secondary parts are present, they develop also divergently in relation to the parts of the first order, but basifugally if a single division only is taken into account.

Type 4. *Ternate.*—Here we have two opposite parts developed from one of a higher order. *Trifolium, Cytisus,* and *Fragaria* represent the type. If parts of the second order are present, they may be ternate, as *Aquilegia, Thalictrum,* &c. The parts of the second order may be ternate, but in the parts of higher orders only the middle part, or one of the side-parts ternate, as *Aralia spinosa, Thalictrum flavum,* &c.; or, lastly, parts of the second order may be produced as bifurcations of the side-parts of the first order. This is well seen in *Platanus, Æsculus Hippocastanum, Ranunculus, Aconitum,* &c.

In these four types the parts of the leaf are developed by the edges of the epiphyll only; in the next two types the parts of the leaf are developed from the inner side, as well as the edges of the epiphyll.

Type 5. *Cyclical.*—To this type peltate leaves belong, and they may develop their parts in various ways, but most frequently basipetally. As examples, we may take the *Tropæolum,* Castor oil, Geranium, Lupin, &c.

Type 6. *Parallel.*—In this type we have the parts of the leaf developed in vertical rows on both sides of the middle line, and parallel to the marginal rows. To this type belong many of the

* See 'Trans. Bot. Soc., Edin.,' vol. viii., pp. 381 and 400.

leaves of Umbelliferous plants, as *Fœniculum, Libanotis,* &c. In these the parts develop basifugally; but in *Spiræa lobata* they have a basipetal-cyclical development.

To most of these types both simple and compound leaves belong. It is remarkable that a type seems to run in a natural order. For example: the *Rosaceæ* seem mostly to belong to the basipetal type, the *Leguminosæ* to the basifugal, while the *Ranunculaceæ* are eminently ternate.

The study of leaf-development is very interesting, and not difficult. The leaves are to be dissected out of the bud, and the youngest leaves will be found immediately underneath the growing point of the axis. They must be examined as opaque objects, with a power of about eighty diameters. It is best to mount them as opaque objects, and for this purpose cells of black sealing-wax are very useful. It is essential that the specimen be able to be examined in all lights; and, if the stage of the microscope does not rotate on its own axis, the preparation is best mounted near one end of the glass-slide. The slide is warmed, and a little black sealing-wax placed on the end on which you propose to form the cell. Wax is added drop by drop, until enough has been placed on the slide. The central portion has now to be hollowed out to form the cell. This is easily done by means of a small brass-weight—the $\frac{1}{4}$ oz. letter-weight answers admirably. It is pressed in the middle of the wax, which, rising on each side, forms a wall of wax surrounding the depression. The edges of the cell must be flattened; this can be done by pressing another slide, which has been previously wetted, firmly and evenly on the edges of the cell. If a specimen is to be mounted, a small quantity of cotton-wool is placed in the cell, and the preservative fluid added—distilled water, acetic acid, and creosote answers well. The specimen is now adjusted with that part uppermost we wish shown, and the glass-cover carefully put on, so as not to disturb the specimen. This is the most troublesome part of the process, and if the specimen is once displaced it is very difficult to readjust it. The whole is then sealed in the ordinary way with asphalte. The specimens keep well, and I have some before me put up in 1865, which exhibit all the various parts as well as when first put up.

VI. *On the Microscopical Structure of some Precious Stones.* By H. C. Sorby, F.R.S., &c.

Plate X.*

A paper by myself and Mr. P. J. Butler was read at the Royal Society on February 18th, in which we described the structure of rubies, sapphires, diamonds, and some other precious stones. I shall now give a general outline of the whole subject, including various facts subsequently learned or scarcely suitable for that occasion.

It is so very convenient to be able to prepare the specimens without having recourse to a lapidary, that it will probably be useful to describe how the specimens may be ground to a proper form and thickness and the surfaces polished. I shall confine myself to this; for I have never cut them with a slitting wheel, since I can at any time have that operation performed for me under my own superintendence; and in many cases specimens may be selected of such a form and size that it is quite unnecessary. I usually employ a flat plate of moderately stout sheet zinc, which does not rust like iron, and has none of the injurious or poisonous properties of copper or lead. If it be requisite to grind away much from the specimen, and if it be sufficiently strong, I first use the finest grain-emery and water, and afterwards the finest washed flour-emery. This cuts well without breaking up flawed crystals. It should be so fine and free from gritty particles that it produces a very smooth surface on such soft gems as garnets, and an imperfect polish on harder minerals, like zircons and rubies. The minute scratches should be removed and the surface polished by means of a

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EXPLANATION OF THE PLATE.

Fig. 1.—Fluid-cavity in sapphire (mag. 20 linear), with large spherical vacuity.
" 2.— " " showing the appearance when boiling violently as it cools; mag. 20 lin.
" 3.—Fluid-cavity in sapphire, partially divided by projecting plates; mag. 50 lin.
" 4.—Fluid-cavity in sapphire, of irregular form; mag. 50 lin.
" 5.—Crystals enclosed in ruby; mag. 50 lin.
" 6.—Fluid-cavity in aquamarina, with two fluids and a vacuity; mag. 150 lin.
" 7.—Curious cavity in spinel, with crystals and fluid; mag. 100 lin.
" 8.—Fluid-cavity in emerald, with soluble crystals; mag. 200 lin.
" 9.—Crystal enclosed in diamond, surrounded by a cross when seen with polarized light; mag. 100 lin.
" 10.—Crystal enclosed in diamond, with associated crack; mag. 100 lin.
" 11.—Crystal enclosed in ruby, surrounded by a cross when seen with polarized light; mag. 75 lin.
" 12 & 13.—Crystals in spinel, surrounded by cracks mag. 50 lin.

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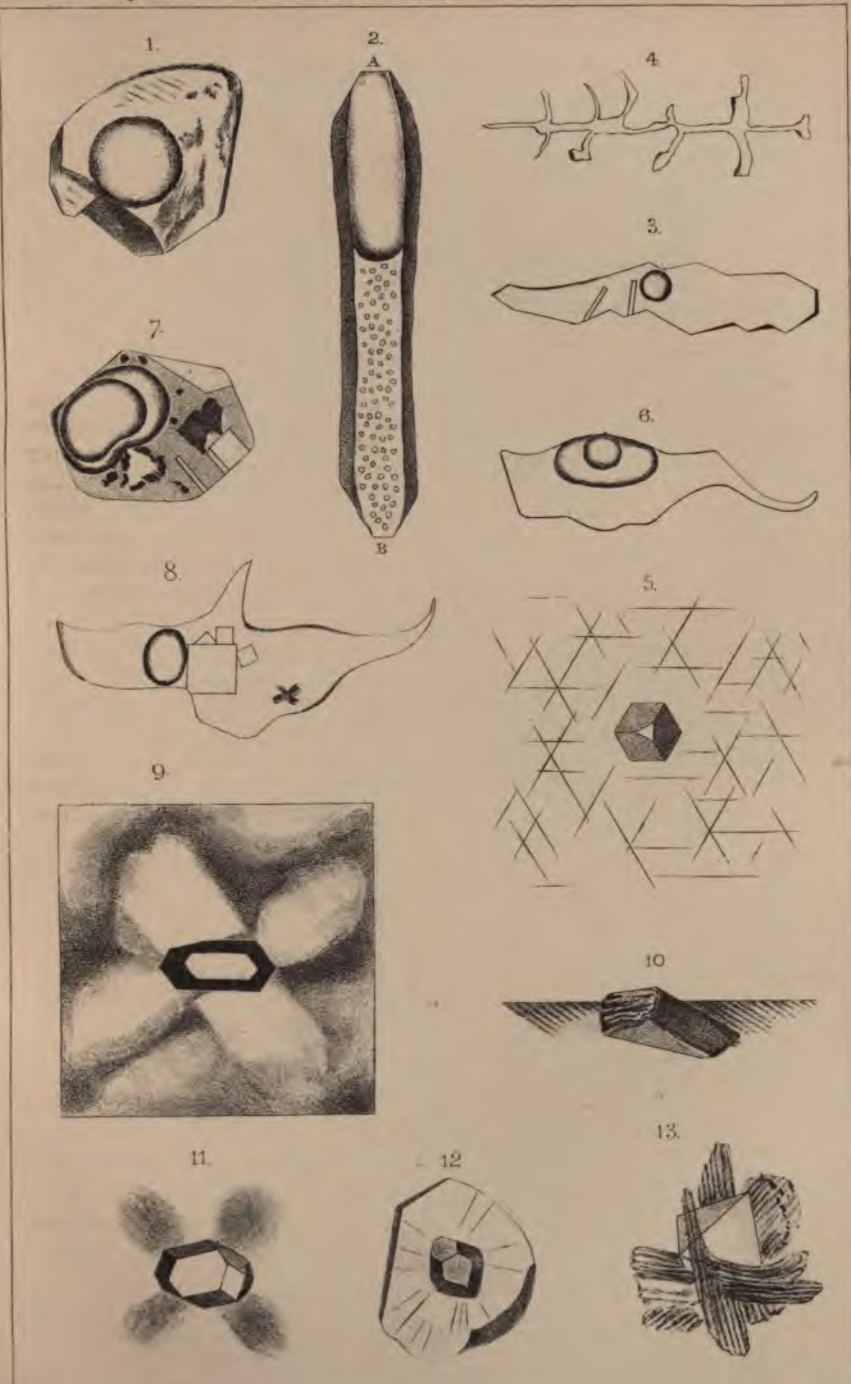
* The accompanying Plate has been printed from the stone used to print the plate in the Proceedings of the Royal Society, which has been most courteously *lent* for the purpose by Dr. Sharpey, Sec. R. S.—Ed. M. M. J.



H. C. Sorby del. W. H. Wesley lith.

Fluid cavities and crystals in precious Stones.

flat Water-of-Ayr, or other very fine and even-grained stone. It is very difficult to grind small crystals if they be merely held in the fingers, and almost impossible to make the surfaces flat; but a simple contrivance renders it easy and ensures a good result. The specimen should be fastened near one end of a piece of glass, about one inch broad and two long, and one or more strips of glass, one over the other, fixed at the opposite end, so as to be about as thick as the specimen. By this contrivance we easily get a good bearing on the zinc plate, and can grind and polish the specimens so that the face is quite flat. A cement made of shell lac melted with Canada balsam is very convenient, since it is hard enough and yet sufficiently fusible. After polishing one side, the specimen should be taken off and the polished surface turned towards the glass; and one or more pieces of glass fixed at the opposite end, so that they may be of almost exactly the same thickness as the specimen after it has been properly ground down. By looking through it at a candle, any deviation from parallelism in the opposite faces can be recognized by the apparent change in the position of the flame; and, if necessary, the error may be corrected by grinding more away from either the glass or the mineral. It may then be taken off by the aid of heat, the greater part of the cement removed mechanically, the rest dissolved away by digesting in alcohol or other suitable solvent, and the specimen mounted on a slide with Canada balsam. In the case of gems this process gives well-polished surfaces; but, since softer minerals do not take a good polish and are easily scratched, it is much the best to mount over them with balsam a piece of thin glass cut of the proper size and shape.

The thickness of the sections must depend to some extent on the character of their structure. I think that in many cases they are cut too thin. By far the best plan is to examine them as soon as they are sufficiently thin to be partially transparent, and to judge from what is seen whether they should be left thick or made thinner. If they contain comparatively large fluid cavities, or enclose crystals which require only a low magnifying power, they would be spoiled by being cut thin: whereas, if the structure requires a high power, a thick section might be objectionable. I have prepared thick sections for some purposes, and can nevertheless use high powers to examine the minute fluid-cavities lying near the surface; and since, moreover, we can reduce their thickness when found necessary, I am decidedly in favour of leaving them rather too thick than otherwise.

Probably no mineral could show more interesting phenomena than the fluid-cavities in sapphire, Figs. 1, 2, 3, and 4; but they are unfortunately so rare, that very few persons could hope to obtain such beautiful specimens as those belonging to Mr. Butler, who has had unusual opportunity for procuring them, and made

excellent use of it. When slightly warmed the liquid expands with such extreme rapidity that the volume is doubled by a very moderate increase of heat, and at 31° C. the expansion for one single degree centigrade is equal to no less that one-fourth of the bulk, as shown in the paper already cited.* After having been warmed so as to expand and fill the cavities, the liquid on cooling often suddenly boils violently; and when these phenomena are observed under the microscope, they are extremely curious and interesting. Mr. Butler has contrived a very ingenious apparatus, which enabled him to show these facts to great advantage at the Soirée of the Royal Society on March 6th.

Rubies differ from sapphires in many particulars, which is probably due to their occurring in a different class of rocks. Mr. David Forbes informs me that, as far as he can learn, rubies are derived from granitic rocks, but sapphires from metamorphic limestones. The fluid-cavities in rubies sometimes contain what seems to be water, and also the more expansible liquid met with in sapphire. These facts correspond to what I have seen in the quartz of some of the felspathic rocks of Scotland, which differ but slightly from fine-grained granites.

I have repeatedly mentioned in various papers that the bubbles in very minute fluid-cavities exhibit a curious and interesting spontaneous motion, analogous to that of all solid substances in a state of very fine division, when free to move about in liquids. The minute fluid-cavities in some rubies show this phenomenon to great perfection; but unfortunately specimens containing them are rare. The rapidity of the movement depends on the size of the bubbles. It is not seen to advantage if their diameter is more than $\frac{1}{10000}$th of an inch; but when only $\frac{1}{50000}$th, they move about in the most surprising manner, just as if they were minute animalcules trying to escape, and exploring every nook and corner of the cavities.

In the paper by myself and Mr. Butler, there is an account of my experiments on the rate of expansion of the fluid in sapphires, which corresponds closely with that of liquid carbonic acid. There seemed every reason to conclude that it could be no other substance, and Mr. W. G. Lettsom has since told me that Geissler of Bonn has been led to the same conclusion by entirely different facts. He enclosed crystals containing the fluid in a tube, which, on exhaustion, showed the spectrum of atmospheric nitrogen, when electric sparks were passed through it. Arrangements had been made, so that the crystal could then be broken, and after that the tube gave the spectrum of carbonic acid. This fact, coupled with those described in the above-named paper, seems to prove beyond all doubt that the fluid is liquid carbonic acid; but, as was therein shown, it was

* Proceedings of R.S., vol. xvii., p. 291.

probably enclosed, not as a liquid, but as a highly-compressed gas, which condensed into a liquid on cooling. There is every reason to believe that, when expanded, so as to fill the cavities, it is in the state described by Caignard Latour,* characteristic of liquids just before they pass into the condition of compressed gases; and therefore, though the cavities are full at a heat no greater than that of summer, the mineral may have been formed at the moderately elevated temperature apparently necessary to explain the origin of metamorphic rocks. I have never seen in sapphire any trace of the second liquid (an aqueous solution) which occurs in topaz and aquamarina, Fig. 6; and hence, probably, the carbonic acid was derived from the decomposition of limestone by silica or alumina, when little or no water was present.

Rubies, sapphires, and spinels, also often enclose many small crystals, of several different kinds of minerals. Sometimes they are arranged parallel to planes of the crystal, so as to give rise to symmetrical structures, Fig. 5. Some are so very thin and flat, that they show the colours of thin plates by reflected light, and look like scales from a butterfly. Others are perfect crystals, resembling those of spinel; and others have a curiously curved outline, and can only be recognized as crystals by the aid of polarized light.

Fluid-cavities are so very common in emeralds, that they may often be seen even in the clear gems, mounted in rings. Their presence is good evidence that it is a genuine emerald; since no artificial glass would show them, however skilfully the colour might be imitated. They contain what seems to be a saturated aqueous solution of alkaline chlorides, from which small cubic crystals have been deposited, Fig. 8. On applying heat to the specimen, these crystals dissolve, and recrystallize when it has become cold. Cavities similar to them in all important particulars are very common in the minerals of the ejected blocks found at Monte Somma, and also in the quartz of some of the Cornish granites, as described by me some years ago.†

The various kinds of garnet cut as jewels are often comparatively free from cavities or enclosed crystals; but the small common garnets in mica schist are often so full of crystals, that certainly only the smaller portion of the whole bulk is made up of the true substance of the mineral. After looking at such crystals, it seems no wonder that the chemical composition of some minerals is irregular and anomalous, when care is not taken to pick out clear and transparent specimens, which can be examined with the microscope and proved to be free from mechanical admixtures.

The jargons which come to England from the Ceylon market

* 'Annales de Chimie,' 1822, vol. xxi., pp. 127 and 178; xxii., p. 410.

† 'Quart. Jour. of Geol. Soc.,' 1858, vol. xiv., p. 453.

are on the whole very free from crystals or cavities; but I have seen a few fluid-cavities showing no facts of particular interest. Small hair-like crystals are common, arranged parallel to some of the planes of the crystal; and sometimes the whole jargon is made up of alternating thin plates, like a complicated system of twin crystals, causing it to appear as if ruled all over with parallel lines; which are more or less distinct and variously coloured, according as the plane of the plates is more or less inclined to the line of vision.

The most interesting of the commoner objects seen in diamonds are the enclosed crystals. Brewster* was led to conclude that they were small cavities containing some elastic substance, which had exerted strong pressure on the surrounding diamond. I have, however, been able to examine more and better specimens than he described, and find that they are really enclosed crystals, which have a strong depolarizing action on polarized light, giving well-marked colours, quite unlike anything due to mere cavities. Brewster has shown that the optical characters of diamonds are often similar to those of hardened gum, and this fact may often be made use of in recognizing that mineral; but some of unusual beauty and purity are in a perfectly crystalline state, and have no more action on polarized light than any other crystals of the regular system. The minute enclosed crystals seem to have resisted the general contraction of the substance of the diamond, and have impressed on it a depolarizing action, which gives rise to a black cross round each crystal, Fig. 9; whilst in other cases the tension has been relieved by the formation of cracks, Fig. 10. Similar phenomena may be observed in rubies, Fig. 11, and spinels, Fig. 12; and they will probably be found to be a common effect of the unequal contraction of minerals enclosed one within the other, whether large enough to be visible to the naked eye, as described by Mr. David Forbes,† or so small as to require the aid of the microscope. This explanation is strongly supported by what is seen in the case of crystals deposited in blow-pipe beads. By fusing zircon with borax, to which a good deal of microcosmic salt has been added, and keeping it hot over the lamp, cubic crystals of phosphate of zirconia are deposited in it. By placing the bead under the microscope whilst still hot, we can see that cracks form round the larger crystals as the temperature falls; just as if they contracted less than the surrounding borax. Probably the further study of such facts will enable us to ascertain more accurately the real temperature at which various rocks have been formed, and furnish another illustration of the value of the microscope in studying some of the greater problems of physical geology.

* 'Trans. Geol. Soc.,' 2nd series, vol. iii., p. 455.
† 'Edinburgh New Phil. Journal,' July, 1857.

VII.—*On the Construction of Object-glasses for the Microscope.*

By F. H. Wenham.

(*Continued from page* 173, *No. III.*)

The lens to be tested is adapted to the microscope, having the ordinary Huyghenian eye-piece. On placing the globule either in or out of focus, the luminous point expands into a ring. If the object-glass is under-corrected for colour, as in a single lens, the bright ring appears within the focus, the outer margin is red, and the inner circle green. If the lens is over-corrected, the bright ring appears *without* the focus, with the colours in the same order as before. A practical knowledge only, derived from these appearances, can determine the amount of concavity to be given to the flint, or difference of convexity in the crown, for obtaining the desired correction; but even in the most experienced hands it generally involves several alterations to secure perfect achromatism. When this is corrected as far as practicable, a pale-green colour only is perceptible beyond the focus. This arises from the secondary spectrum, or relative difference in the width of the prismatic colour spaces of the crown and flint, and seems to be a variable condition, according to the composition of the glass employed.

Though correction for spherical aberration is intimately related to that of colour—a single lens, when finally achromatized, being also nearly free from spherical error; yet, in a combination of three pair, when matched so as to be achromatic, this may be so considerable as to render the object-glass useless, and is oftentimes exceedingly troublesome to remedy. The error may arise from an improper proportion between the relative foci of the lenses—as the back being too long. I have before stated that in the form that I have advocated, the spherical aberration is mainly corrected by giving thickness to the front lens, and by properly adjusting the distance between them. In a glass spherically under-corrected the light from the globule is greatest within the focus, and when set out of focus speedily vanishes and becomes diffused; in the case of spherical over-correction the contrary appearances result. When the relative distance of the lenses is rightly adjusted, the light spot expands equally, and is of the same intensity, for a short distance on either side of the focus, in which the globule should appear with a clear bright margin. The object-glass is now in a proper condition for testing errors of construction and workmanship.

To examine the condition of the oblique pencils, and consequent flatness and distinctness throughout the field, a small globule is selected, and brought to the edge, using the lowest eye-piece; if the bright point in the centre of the globule, when a little out of focus,

approaches to the inner side of the concentric light-rings, as in Fig. 1, it is termed "outward coma," and indicates that the front incident surface of the back triple is too *convex*. If, on the other hand, the bright spot is on the outer side of the rings, or next the margin of the field of view, there is "inward coma," which shows that this same surface is too flat. I have previously remarked that this curve has a powerful effect on the flatness of field and perfection of the oblique pencils, and for these no other correction is generally requisite than an alteration in this radius.

Fig. 1.

Before the glasses are finally cemented in their cells they should be carefully tested for centering; for this purpose a very minute globule is selected, and placed exactly in the centre of the field. If the bright spot appears eccentric, with the rings thus (Fig. 2), the pair of lenses which occasion the error should be shifted on each other while warm enough to cause the Canada balsam by which they are cemented together to yield, till on repeated trial the error is corrected. This is important, as the least fault of centering materially impairs the performance of an object-glass. But with the precautions that I have adopted in the construction, to be hereafter explained, errors of centering cannot occur.

Fig. 2.

There is yet one other globule test for object-glasses, to indicate accuracy of workmanship, or whether the lenses are worked to true spherical surfaces. If the rings from a minute globule appear of an irregular wavy outline, as shown by the annexed cut (Fig. 3), either approximating to a polygon or triangle, it shows that one of the surfaces at least that refracts the rays is of this form. Such workmanship is inexcusable, and those that cannot avoid it had better let glass-grinding alone.

Fig. 3.

Finally, there is an appearance that I have sometimes seen in our best object-glasses, when focussed away from a globule, *viz.* "Newton's rings;" this shows that in the

contact surfaces of one of the pair of lenses, the convex is deeper than the concave; and bears hard in the middle. This may have no worse effect than loss of light; but still it is as well avoided.

On the Quality of the Glass employed in the Construction of Object-glasses.

Under this head I can offer but very little information, for in common with all other workers in this direction, I have merely made use of such various samples of glass as I have been able to procure. The whole secret of the ingredients used, their proportions and chemical constitution, is in the hands of the makers; and though the two or three of them that have paid attention to the manufacture have doubtless well studied the particular application of both the flint and the crown for the construction of microscope lenses, yet the best that we can procure falls far short of the requirements of the case for the very highest powers.

It is usual to denote the quality of flint-glass by its density, but this in reality forms no accurate criterion of its dispersive power. Formerly, under this impression, I procured a quantity of dense flint, made by Chance, of Birmingham—very hard, white, and free from liability to tarnish, and to all appearance as good a quality of glass as I had seen. Its density was 3·867, but on trial I found it unfit for the construction of the highest powers, as its dispersive power was lower than the Swiss 3·686, or even the 3·630 that I had employed previously, while its reflexion was much greater. Some ingredient had been added which increased the refraction, and probably lessened the dispersion; and, of course, in a correcting concave, the latter quality alone is needed, and the lower the refraction the better.

The crown and flint employed in the $\frac{1}{8}$th described at the commencement of this essay, of the respective densities of 2·437 and 3·686, had a relative dispersive power of 11 to 25; this having been very accurately determined by two prisms, whose angles were in this proportion, and which when superposed were perfectly achromatic. Faraday made some dense flint, having a specific gravity as high as 6·4, but we have no information relating to its refractive and dispersive power.

We are thus somewhat ignorant of the material elements of construction employed in the microscope object-glass; and it would be very desirable that a series of experiments should be made, with various combinations of all the known materials that can be used in glass-making, and the resulting compounds worked into equilateral prisms, and their refractive and dispersive powers tabulated, with the component ingredients. A few years back this investigation

would have been a very troublesome and expensive one, by reason of the interference of the excise laws, and the necessity of employing a regular glass furnace, to operate on large quantities at once, in order to lessen the effects of impurities. But now, by means of the recently-invented gas furnaces, the greatest possible heat may be commanded, under perfect control, and thus enable the operator to combine materials in very small quantities without the intrusion of impurities from the fuel and furnace-lining, or crucible, which may be of platinum. The results of the investigation would unquestionably be valuable, and we might possibly be able to discover compounds which would neutralize the secondary spectrum. The late Thomas Cooke has repeatedly stated that if, while viewing a difficult double star through a telescope, some one was to sweep away the secondary spectrum, he would scarcely be able to discover any improvement, either in light or definition. But I am of opinion that the case is different with a microscope object-glass, wherein, with the highest powers, every trifling error is so enormously magnified, and in resolving the most difficult tests the effects of irrationality are at times very apparent.

(*To be continued.*)

VIII.—*On the Rhizopoda as embodying the Primordial Type of Animal Life.* By G. C. Wallich, M.D., F.L.S., &c.

The increased importance which has attached to the study of the Foraminifera, since their agency in the formation of vast geological strata during both past and present periods of the earth's history became clearly recognized, renders it highly desirable that an attempt should be made to obtain some deeper insight into their nature and vital capabilities than has heretofore been acquired. For a very little consideration must suffice to convince those who will be at the trouble of examining the statements concerning the living protoplasm of these organisms, which have been promulgated on high authority and very generally received, that they trench far too closely on the miraculous to be amenable to the ordinary rules of scientific investigation.

It is a very singular fact that whereas modern writers on the Foraminifera have, by common consent, classified them in conformity with characters derived from their shells—laying marked emphasis on the advancing complexity of structure which is noticeable amongst the various genera—they seem to have unhesitatingly attributed to the living animal portion through whose instru-

mentality these shells are constructed, functions which assuredly do not belong to it, and even become but partially manifest when we arrive at the highest or Amœban Order of Rhizopods.

This grave misconception would seem to have chiefly originated in the descriptions published on the one hand, respecting the primordial simplicity of the gelatinous particle which constitutes the body of the Foraminifer; and, on the other, regarding the marvellous functions this particle is supposed to perform. In short, we have been expected to believe that, in these the lowest forms of animal existence, important vital effects can be, and in point of fact are, produced in the absence of adequate causes; as if nature had here stepped aside from the path of law to trifle on the very threshold of organic creation.

But lest it be imagined that I am overstating the case, let me quote a paragraph from Dr. Carpenter's work on the Foraminifera, which is at the same time the most recent and the most elaborate treatise we possess on the subject. In speaking of the protoplasm of this family of the Rhizopoda, he describes it as a substance which "does not present any such differentiation as is necessary to constitute what is commonly understood as 'organization' even of the lowest degree and simplest kind; *so that the physiologist has here a case in which those vital operations which he is accustomed to see caused by an elaborate apparatus are performed without any special instruments whatever*; a little particle of homogeneous jelly arranging itself into a greater variety of forms than the fabled Proteus, *laying hold* of its food without members, *swallowing* it without a mouth, *digesting* it without a stomach, appropriating its nutritious material without absorbent vessels or a circulating system, moving from place to place without muscles, feeling (if it has any power to do so) without nerves, propagating itself without genital apparatus, and not only this, but in many instances forming shelly coverings of a symmetry and complexity not surpassed by those of any testaceous animal." *

Now let us see how far this description can be said to apply to the animal of the Foraminifera, or, indeed, how far it can be said truly to portray the vital powers of any of the Rhizopoda whatever. But in order to do this, it is necessary that the various points touched upon should be considered, with reference to each of the three Orders into which the Rhizopoda have been divided, in virtue of their ascending degrees of protoplasmic differentiation.

First, then, as regards the lowest and simplest known Order of animal being—that to which the Foraminifera are now unanimously referred—in which there occurs the smallest amount of deviation from homogeneity in the protoplasm, and no definite nucleus or contractile vesicle have as yet made their appearance.

* Carpenter, 'Introduction to the Study of the Foraminifera,' Preface, p. vii.

The protoplasm of the Foraminifer cannot strictly be said to be homogeneous. The jelly-like medium is the matrix in which are suspended not only an infinite number of extremely minute granules of greater density than the protoplasm itself, but also a varying number of larger corpuscules which have the appearance of being composed of aggregations of the above-mentioned minute granules. There is no reason whatever to regard these aggregations as being merely accidental. On the contrary, their uniform size, their uniform ochreous-yellow tint, their presence in all the Foraminifera in which a systematic search has been made for them, and lastly the strong evidence we possess of their constituting the germs of a new generation in this family (as I have formerly shown that similar bodies do which we find in the Polycystina and the whole of the higher orders of Rhizopods), are sufficient to warrant the inference that they represent the rudimentary condition of the nucleus. The assumed homogeneity is accordingly disposed of.

The body of every Foraminifer being encased within a shell is quite incapable of those "Protean" changes of form which are attributed to it; or indeed of any further changes of form than those arising from the protrusion and retraction of its pseudopodia. The Foraminifer neither lays hold of its food, nor swallows, nor digests it, inasmuch as the entire operation of nutrition consists in the elimination, from the fluid medium in which it lives, of the elementary substances entering into the composition of protoplasm and shell-tissue. It moves from point to point solely by a contractile effort of the pseudopodia. It "feels;" for any unexpected or undue irritation cause the pseudopodia to recoil. It possesses no nervous system in the usual acceptation of the term; but, despite all we know and all we see, he must be a bold man who will take on himself to say positively that a diffused nervous energy may not reside generally in its protoplasm. The Foraminifer certainly propagates without genital organs; but, as already shown, it possesses in the granular corpuscules above described—for which I have elsewhere suggested the name of *Sarcoblasts* as being expressive of their function—a reproductive apparatus quite as complete as we can expect to find in organisms otherwise so simple.

How the sarcoblast originates, whether any sexual elements exist in it, or any process of fecundation takes place prior or subsequently to its extrusion from the parent body, we have as yet either failed to detect, or our optical appliances have not been sufficiently powerful to show.

Lastly, bearing in view the undeniable "symmetry and complexity" observable in the shells of the Foraminifera—a complexity "unsurpassed" in the shells of any other testaceous animals—it would surely be erring on the safe side to ascribe this symmetry of form and this singular complexity of [illegible] some more valid

agency than that of mere molecular aggregation. Amongst the Amœban Rhizopods I formerly endeavoured to show that unless we are prepared to deny the evidence of our senses, we must admit the presence of a selective and adaptative power, whereby, in the midst of inorganic materials of the most varied kind, only those which are best suited to the wants of the animal are picked out and their particles arranged, in an order and with a degree of regularity which it becomes impossible otherwise to account for. But, strange as it may appear, there exists no room for doubt, that although the Amœban Rhizopods are those in which the development of something akin to organization has reached its highest limit, by far the greatest amount of symmetry and intricacy of shell-structure is attained, not by them, but by the Foraminifera and Polycystina, which are the simplest as regards protoplasmic constitution. Of a truth, there is something more in the "simplicity" of these humble exponents of vitality than has heretofore been conceded to them!

I am quite ready to allow that, in claiming the mode of nutrition above indicated for the Foraminifera (and also for the Polycystina, from whom they differ in no respect except the material of which the shells are composed, the mode in which the shell-material is disposed, and the ultimate forms which it is made to assume), I virtually connect together within the limits of one subdivision of organic nature, structures which exhibit vital phenomena which belong to another. That is to say, whilst the mode of nutrition maintained by me as prevailing in the two lower Orders of the Rhizopoda would establish their title to be regarded as vegetables, that which prevails in the highest or Amœban series leaves no room for doubting that they are strictly animal in their nature. The difficulty is admitted. But, difficulty or no difficulty, there is no gainsaying the facts; and unless we are inclined to increase rather than diminish difficulty by constituting a neutral and intermediate group, half animal, half plant, in which to include the lowest series of Rhizopods from the one side and such organisms as the Diatoms from the other, there is no help for it but to acknowledge that our knowledge fails in this instance to keep pace with our facts, and to wait patiently for the time when these seeming anomalies may admit of scientific reconciliation. Under any aspect of the matter, let us insist on the production of the most complete evidence before we permit those who have a preconceived hypothesis of primordial life to support, to beguile us, even if they succeed in beguiling themselves, into a belief which is as incompatible with reason as it is with observation.

If we attempt to apply the description given in a preceding page of the vital properties of the Foraminifera to the families which may with propriety be ranged side by side on the second or intermediate Order of the Rhizopoda, in virtue of their possessing

a definite nucleus in addition to the sarcoblasts, but which, in common with the Foraminifera and Polycystina of the lowest Order, do not possess a contractile vesicle, we are met by precisely similar discrepancies: every function being the same in kind, and performed through the same means. And let it be particularly borne in mind, as affording most conclusive testimony to the fact that nutrition is effected in these two Orders in the manner I have described—that is to say, not by the inception of already-formed organic products into the substance of the living protoplasm, but by a power inherent in that protoplasm of converting inorganic elements into nutritive matter and shell-tissue,—that under no circumstances have solid matters, such as we constantly detect, and in fact see introduced as food, within the bodies of the Amœban Rhizopods, been heretofore detected within the bodies of the Foraminifera. Where foreign substances have been found imbedded within their protoplasm, these have either been of such a nature, or concomitant appearances have been such as to leave no room for doubt that their introduction was due to violence or accident.

Lastly, if we compare the description already referred to of the vital attributes and characters of the Foraminifera with what we observe in the highest, or Amœban Order of the Rhizopods, our bewilderment is by no means abated. True, the description was not applied to any other family than the Foraminifera. But from that family it could not have been taken, or from any of the families whose habitats are oceanic. On the other hand it is not easy to conceive it was taken from the Amœban group, and I should assuredly not venture to assert that it was held to be applicable to it, did not Dr. Carpenter in a subsequent part of his work (chap. ii., p. 12) leave no room for doubt on the subject. Speaking of the Rhizopod group generally, he writes as follows:—"In none of its members can any traces be found either of a nervous or vascular system. The digestive apparatus is reduced to its simplest possible condition; of a circulating system, a mere rudiment only can be distinguished; special organs for respiration and excretion seem altogether wanting; and although there is reason to believe that true sexual products are formed by many of them, yet these develop themselves out of the general substance of the body, instead of in distinct organs set apart for their evolution. . . . They obtain food either by moving actively in search of it, or by putting forth prehensile appendages which bring it to them; they introduce the food into the interior of their bodies, and subject it to a process of digestion whereby its nutritious material is extracted from the indigestible residue, which is cast forth by an act of defecation; they diffuse this material through the general substance of the body, both by the general movements of its walls and by the agency of what seems to be a special contractile or

The expression that "the digestive apparatus is reduced to its simplest *possible* condition" clearly points to the least and not the most highly differentiated family; in other words, to the Foraminifera. On the other hand, the idea of their "moving actively in search of food," "introducing food into the interior of their bodies," and the possession of "a special contractile organ," as clearly point to the Amœbans; for I presume no one will undertake to say these epithets are applicable to the Foraminifera. Again, had this supplementary description been intended to apply principally to the Foraminifera, it is singular that all allusion to the remarkable symmetry and complexity manifest in their shell formation should have been omitted in it. But without going further, I hope the correctness of the assertion with which I opened these remarks will already have become manifest, namely, that it is high time that the student who desires to investigate the characters of this most interesting section of the animal kingdom should be enabled to turn with confidence to some accredited type of primordial life and take it as his starting-point, instead of finding himself involved in a maze which must effectually baffle him.

I now beg leave to say a few words regarding the so-called "Cyclosis," or circulation of minute granules, which it has been customary to assert takes place both within the body of the Foraminifera and along the projected pseudopodia. Although well aware that my views on this as on other vital phenomena observable in the protoplasm of the Rhizopoda are not in accordance with those which have been so authoritatively enunciated by others, I feel bound to express my conviction that such cyclosis is in no way to be regarded as an independently acting vital function resident either in the protoplasm proper, or in the granules suspended within it; but is a purely mechanical result, affecting the granules only through movements executed by the vital contractility which is an inherent attribute of animal protoplasm. When these movements cease, the circulation of granules ceases; when they are resumed, the circulation of granules is resumed also. In the testaceous families of the lower types, and notably in the Foraminifera and Polycystina, these movements become manifest only to the extent of causing a nearly constant efflux and influx, in opposite directions, of the protoplasmic matter entering into the formation of the pseudopodia and also in that portion of it which, in most cases, constitutes a delicate investing layer on the exterior surface of the shells. It is, however, in the naked *Amœbæ* that the *pseudo*-cyclosis attains its most energetic and characteristic limit, and we can most readily perceive that it is produced by a mechanical and not a special vital agency. In the large pseudopodia of *Amœba* we see at once that the appearance of an advancing and a retrograde current is due to the fact that the lower surface of the organism is fixed as it were

to the plane on which it rests, whereas its upper or free surface only is being projected into pseudopodial extensions. In short, the effect is identical in character with that which would present itself if, after filling a transparent and highly elastic bladder—as, for example, a bladder formed of extremely thin caoutchouc—with some viscid and transparent fluid in which granular particles of slightly greater specific gravity than the fluid itself were suspended, we were to roll it slowly along a flat surface. In such a case, the upper stratum of granules would in reality be moving forwards in the direction in which the bladder was being rolled; whereas the inferior stratum, although at rest, would appear to be retrograding; for the same reason that when a railway-train is slowly and steadily put in motion, the platform appears to be moving from the observer seated in one of the carriages. Now, as regards the cyclosis, this result could not take place, if the two phenomena—namely, the vital contractility of the protoplasm itself and the circulating force by means of which the granules are impelled—acted independently one of the other. Did they act independently, any cessation or alteration in the one would not necessarily involve a cessation or alteration in the other, but the circulation of the granules would continue unchecked even when the protoplasmic mass had attained a state of perfect rest. And notably, when the direction in which the protoplasmic mass had for a time been moving became suddenly reversed, the direction of the granular movement would remain unaltered, at least for a period, were the force producing it an independent one. But the direction which the granules continue to take under these circumstances becomes immediately reversed also, proving thereby that it simply follows the direction imparted to it by the protoplasm. It only remains to be stated that these phenomena are observable whenever a fresh pseudopodium is projected; every modification in the direction taken by the current of granules being distinctly referable to some corresponding change in the form being assumed by the protoplasmic body generally.

In conclusion, I would observe that although a step or two have already been gained in our knowledge of these lower forms of animal life, much remains to be achieved before it can with truth be said that we have mastered these difficult inquiries. What is the precise composition of protoplasm? What vital functions is it capable of performing? In what does its so-called differentiation consist? Does any recognized difference in the mode of deriving nourishment necessarily involve a difference in the atomic constitution of protoplasm? And lastly, Can we with any truth be said to have as yet arrived at that climax in microscopic analysis at which it is safe to assert that our methods and apparatus are actually able to enter into competition with the subtlest creations

of nature? It is merely with a view to indicate the direction our future researches on these subjects should assume that the present observations are offered. For although new facts may dawn upon us, and new triumphs of optical and mechanical skill may hereafter enable us to detect subtleties of structure as yet invisible to our senses, at the risk of giving utterance to a threadbare truism, I would express my faith that every new fact and every additional means of observation we may in future command will only serve to prove more incontestibly—if further proof be needed—that even in her subtlest workings Nature still abides by Law, and permits no exceptional case—such as that which has been assumed to take place in these lowest forms of life—to disturb her harmony.

IX.—*On the Structure of the Red Blood-corpuscle of Oviparous Vertebrata.* By William S. Savory, F.R.S.*

The red blood-cell has been perhaps more frequently and fully examined than any other animal structure; certainly none has evoked such various and even contradictory opinions of its nature. But without attempting here any history of these, it may be shortly said that amongst the conclusions now, and for a long time past, generally accepted, a chief one is that a fundamental distinction exists between the red corpuscle of Mammalia and that of the other vertebrate classes; that the red cell of the oviparous vertebrata possesses a nucleus which is not to be found in the corpuscle of the other class. This great distinction between the classes has of late years been over and over again laid down in the strongest and most unqualified terms.

But I venture to ask for a still further examination of this important subject.

As the oviparous red cell is commonly seen, there can be no doubt whatever about the existence of a "nucleus" in its interior. It is too striking an object to escape any eye; but I submit that its existence is due to the circumstances under which the corpuscle is seen, and the mode in which it is prepared for examination. I think it can be shown that the so-called nucleus is the result of the changes which the substance of the corpuscle undergoes after death, and which are usually hastened and exaggerated by exposure, and the disturbance to which it is subjected in being mounted for the microscope. When a drop of blood is prepared for examination,

* Through the kindness of Dr. Sharpey, Sec. R. S., we are permitted to reproduce this most important contribution of Mr. Savory's.—Ed. M. M. J.

little or no attention is given to the few seconds, more or less, which are consumed in the manipulation. It is usually either pressed or spread out on the glass slip, and often mixed with water or some other fluid. But it is possible to place blood-cells under the microscope for examination so quickly, and with such slight disturbance, that they may be satisfactorily examined before the nuclei have begun to form. They may then be shown to be absolutely structureless throughout; and, moreover, as the examination is continued, the gradual formation of the nuclei can be traced. The chief points to be attended to are—to mount a drop of blood as quickly as possible; to avoid as much as possible any exposure to air; to avoid as much as practicable contact of any foreign substance with the drop, or any disturbance of it.

After many trials of various plans, I find that the following will often succeed sufficiently well. Having the microscope, and everything else which is required, conveniently arranged for immediate use, an assistant secures the animal which is to furnish the blood (say, a frog or a newt), in such a way that the operator may cleanly divide some superficial vessel, as the femoral or humeral artery. He then instantly touches the drop of blood which exudes with the under-surface of the glass, which is to be used as the cover, immediately places this very lightly upon the slide, and has the whole under the microscope with the least possible delay. Thus for several seconds the blood-cells may be seen without any trace of nuclei; then, as the observation is continued, these gradually, but at first very faintly, appear, and the study of their formation affords strong proof of their absence from the living cells.

The "nucleus" first appears as an indistinct shadowy substance, usually, but not always, about the centre of the cell. The outline of it can hardly for some seconds be defined, but it gradually grows more distinct. Often some small portion of the edge appears clear before the rest. At the same time the nucleus is seen to be paler than the surrounding substance. Synchronously with this change—and this is noteworthy—the outline of the corpuscle (the "cell-wall") becomes broader and darker. What was at first a mere edge of homogeneous substance, becomes at length a dark border sharply defined from the coloured matter within. Thus a corpuscle, at first absolutely structureless, homogeneous throughout, is seen gradually to be resolved into central substance or nucleus, external layer or cell-wall, and an intermediate coloured, though very transparent, substance. But—and this is significant—these changes are not always thus fully carried out. It not seldom happens that the nucleus does not appear as a central, well-defined, regularly oval mass. Sometimes it never forms so as to be clearly traced in outline, but remains as an irregular, shapeless mass, in its greater *portion* very obscure. Sometimes only a small part, if any, of an

edge can be recognized, most of it appearing to blend indefinitely with the rest of the cell-substance. Sometimes it happens that in many corpuscles the formation of a nucleus does not proceed even so far as this. No distinct separation of substance can anywhere be seen, but shadows, more or less deep, here and there indicate that there is greater aggregation of matter at some parts than at others. Occasionally some of the cells present throughout a granular aspect. I have almost invariably observed, too, a relation between the distinctness of the nucleus and of the cell-wall. When the nucleus is well defined, the cell-wall is strongly marked; when one is confused, the other is usually fainter. This, however, does not apply to colour; on the contrary, when the nucleus is least coloured it contrasts more strongly with the surrounding cell. As a rule, the wall of the cell is more strongly marked than the nucleus.

It will of course be said that the nuclei are present all the while, but are at first concealed by the surrounding substance—the contents of the cell. Thus the fact has been accounted for, that the nuclei are not so obvious at first as they subsequently become. But I think a careful comparison of cells will show that those in which a nucleus may be traced are not more transparent than others which are structureless; and, moreover, when one cell overlaps another, the lower one is seen through the upper clearly enough to show that the substance of these cells is sufficiently transparent to allow of a nucleus being discerned if it exist. When a nucleus is fully formed, it hides that portion of the outline of a cell which lies beneath it. How is it, then, if the nucleus is present from the first, that the portion of the cell over which it subsequently appears is, for awhile, plainly seen?

The success of the observation is of course influenced by numerous circumstances. The rate at which the nuclei form in the corpuscles varies in different animals. I have usually found that in the common frog they are more prone to form than in many other animals—quicker than in most fishes, or even than in some birds. But this does not seem always to depend upon their larger size; for in the common newt, the cells, which are larger than those of the frog, remain, as I have noticed, for a longer period without any appearance of nuclei. But even in the frog it can be satisfactorily demonstrated that the corpuscle is structureless.

I have found, too, that the observation succeeds best with the blood of animals which are healthy and vigorous. Thus the first observations upon fresh animals are usually the most satisfactory. After they have been repeatedly wounded or have lost much blood, the cells are more prone to undergo the changes which result in the production of nuclei.

Again, the formation of nuclei may be hastened, and their appearance rendered more distinct at last, by various reagents.

Acids and many other reagents are well known to have this effect. The addition of a small quantity of water acts in the same way, but less energetically. It hastens the appearance of an indistinct nucleus, but interferes with the formation of a well-defined mass, so that, after the addition of water, the outline neither of the cell nor of the nucleus becomes so strongly marked as it often does without it. Exposure to air also promotes their formation; indeed, as a rule, the nuclei form best under simple exposure. Any disturbance of the drop, as by moving the point of a needle in it, certainly hastens the change, and perhaps it is influenced by temperature.

Sometimes, when the drop of blood has been skilfully mounted, the majority of cells will remain for a long while without any trace of nucleus; but again, in almost every specimen, the nucleus, in some few of the cells, particularly in those nearest the edges, begins to appear so rapidly, that it is hardly possible to run over the whole field without finding some cells with an equivocal appearance.

It would follow, of course, from these observations, that if the living blood were examined in the vessels, the corpuscle would show no trace of any distinction of parts; and this is so. Indeed, in my earlier observations,* before I had learnt to mount a drop of blood for observation in a satisfactory manner, I examined at some length blood in the vessels of the most transparent parts I could select, and several observations on the web and lung of the frog and elsewhere were satisfactory. But still, when the cells are thus somewhat obscured by intervening membrane, one could not generally feel sure that the observation was so clear and complete, but that a faintly-marked nucleus might escape detection. While, therefore, the result of observations on blood-cells in the vessels fully accords with the description I have given, I do not think that the demonstration of the fact that, while living, they have no nucleus, can be made so plain and unequivocal as when they are removed from the vessels.

The question naturally arises, Why, then, does not a nucleus form in the mammalian corpuscle? But while it is accepted that the great majority of these corpuscles exhibit no nuclei after death, excellent observers still affirm their occasional existence; and I am convinced that an indistinct, imperfectly formed "nucleus" is often seen; and the shadowy substance seen in many of the smaller oviparous cells after they have been mounted for some time, is very like that seen under similar circumstances in some of the corpuscles of Mammalia. Many, too, affirm that these corpuscles do not exhibit that distinction of wall and contents which is generally described. It appears to me that this difference of opinion depends on the

* Made many years ago. Other observers have been unable to detect a nucleus *in the living* cells within the vessels.

changes they are prone to undergo. How far the absence of a distinctly defined "nucleus" after death depends on their smaller size, I am not prepared to say.

Many questions of course follow. For example, how far is this separation of the substance of a homogeneous * corpuscle into nucleus, cell-membrane, and contents, to be compared to the coagulation of the blood? and how do the agents, which are known to influence the one process, affect the other? A still further and more important question is, How are these changes in the corpuscles, and in the blood around them, related? But in this paper I propose to go no further than the statement that the red corpuscle of all vertebrata is, in its natural state, structureless. When living, no distinction of parts can be recognized; and the existence of a nucleus in the red corpuscles of ovipara is due to changes after death, or removal from the vessels.

I cannot conclude this paper without acknowledging the great help I have received in this investigation from Mr. Howard Marsh, Demonstrator of Microscopical Anatomy at St. Bartholomew's Hospital.—*Paper read before the Royal Society, March 18th.*

X.—*A Small Zoophyte Trough.* By W. P. Marshall, President of the Birmingham Natural History and Microscopical Society.

In the examination, under the microscope, of small living aquatic objects, animal or vegetable, such as larvæ, or desmids, &c., the want has been felt of a very small open glass trough, small enough in diameter and depth to limit the motion of the object within the range of a low-power objective, without requiring alteration of the stage or the focus, and allowing of black-ground illumination by the parabolic condenser; whilst at the same time retaining the advantages of the ordinary zoophyte trough for observing objects in a natural, free condition, and affording the means of removing the water and reaching the object whilst under the microscope, with a curved needle or fine brush. The following is a description of a simple and convenient little trough that I have contrived for this purpose, and it has been found very useful and satisfactory in work.

An ordinary cell of glass, ebonite, or other material, cemented upon a glass slide with marine glue, has a half cover-glass fixed on with asphalte varnish, and made out of an ordinary round cover-glass cut in half across the centre. A semicircular open trough is

* By the word homogeneous I do not mean to affirm that the substance of the corpuscle is of equal consistence throughout. The central may be the softest part of it. But I regard the corpuscle, in its whole substance, as "having the same nature."

thus formed, of any desired diameter and depth, by selecting the size of cell accordingly; and the *wall* being continued *all round*, gives the important advantage that the slide can be *laid down flat*, without any risk of water escaping; the water is, indeed, held so securely in the covered half of the cell, that it may be turned upside down without the object being displaced.

The water in the trough is readily renewed, and the living object refreshed at any time, by simply laying down the slide *flat*, and filling up the whole cell with water from a pipette, when the object floats out into the open part; and the surplus water is again readily withdrawn by a pipette.

The trough is originally filled, and the object placed in it in the same manner *on the flat;* thus allowing the entire area of the open half of the cell for this purpose, instead of only the narrow opening into the trough; and this affords much facility in the case of delicate objects, such as cast larva skins, that will not bear handling, and have to be floated into their place. Then, to empty the trough, it is held obliquely over a watch-glass, and a small jet from a curved pipette washes out the contents of the trough safely into the watch-glass.

The only practical objection found to these small troughs is, that they are too small to be cleaned inside; but this difficulty is completely got over by simply never letting them get dry, so as to prevent any film forming upon the glass, by keeping the troughs always immersed in a tumbler of clean water.

These troughs have the important advantage that any one can readily make them; the thin cover-glass is easily cut in half by scratching it across with a writing diamond whilst laid on a glass slide, wetted to make it stick close, and then shifting the cover-glass to the edge of the slide, with one of the halves projecting over, when it is separated by a light touch.

XI.—*On the Preparation of Rock Sections for Microscopic Examination.* By David Forbes, F.R.S., &c.

The results of microscopic investigation into the mineral character and physical structure of rocks have of late not only proved how essential an instrument the microscope is for inquiring into their origin, and studying the various changes which they have undergone, or are now undergoing, but also point out that its future and more extended application must throw great light upon many abstruse questions relating to the geological phenomena of nature, by the careful study of minute microscopic details which until lately have been quite neglected or overlooked

The examination of rocks, especially of the more compact or apparently homogeneous ones, by transmitted light, is of much greater importance than when they are merely looked at superficially as opaque objects; and in order to do so it becomes necessary, at least in the case of most rocks, to render them as translucent as possible, by reducing them to the form of their uniform plates or sections; it is therefore proposed in this communication to give a short description, showing how such sections can be prepared, in order to induce more of our fellow-microscopists to direct their attention to this interesting subject, and thereby to assist in advancing the knowledge of the structure of minerals and rock masses.

If a lapidary's bench is at disposal, the preparation of such sections is greatly facilitated; but it is not at all imperative for the amateur microscopist to possess one, since with, it is true, somewhat more labour and patience, the finest sections can be made by hand, not only equally well, but in the case of some of the softer rocks—metamorphic schists and various others, which, especially when making cross-sections, are liable to tear or break up under the rougher and less easily controllable movements of the machine—larger and more perfect sections can be executed by hand than on the lapidary's wheel.

The first point to be attended to is to secure a proper fragment of the rock under consideration, which can be easily done in the case of massive homogeneous or crystalline rocks, by chipping off a piece about from one quarter to three quarters of an inch across, as flat as possible, with the aid of a steel chisel and hammer. Should the specimen, however, be a very small, rare, or valuable one, or if it be required that the line of section should pass along some given direction not easily followed by chipping with a chisel, it is necessary to use a toothless iron saw worked with emery and water, or to resort to what is termed "slitting," an operation performed by any working lapidary (at a trifling expense per square inch of cut surface), by means of a thin steel disk, charged on its edge with diamond powder and set in rapid rotation in his lathe.

One surface of the rough fragment or thin slice thus obtained is now ground down with emery and water, by holding it against the rapidly-rotating pewter plate of a lapidary's wheel, or, in default of this, by the motion of the hand on a circular plate of cast zinc, iron, or stone (from 4 to 6 in. diameter, and $\frac{1}{2}$ to 1 in. in thickness), using in succession various sizes of emery powder down to fine dust, until a perfectly flat surface is obtained; after this, it is now again worked with water alone, upon a small, circular, Turkey hone, until the under-surface becomes beautifully smooth, free from scratches, and almost polished in appearance.

Having thus obtained one finished surface, this is cemented with Canada balsam to a small piece of plate-glass about $\frac{3}{4}$ in. square and

$\frac{3}{8}$ in. in thickness, making both the stone and plate-glass tolerably hot, so that the balsam may sink into the pores, or softer parts of the section, which, upon cooling, remains firmly attached to the glass;—care must of course be taken not to employ a heat so elevated as to risk the expulsion of any liquid which might possibly be contained in fluid-cavities in the specimen.

This small square of plate-glass now serves as a handle when grinding down the other surface upon the lapidary's plate, or by hand, as before described, until the section, which should be examined from time to time, proves to be sufficiently translucent for use under the microscope. It is then finished in precisely the same manner as the former face, with water alone, upon a fine Turkey hone, and is ready for mounting upon its permanent slide. The mounting is done simply by warming the plate-glass square until the balsam is liquefied, when the rock section is carefully transferred on to the gently heated glass slide; afterwards the upper surface of the section is moistened with a drop of turpentine, and a thin glass cover fixed on the top of it with Canada balsam as usual.

The glass slides which I use are all $1\frac{1}{2}$ in. square, a size I consider more convenient than the usual one of 3 by 1 in., both as being less liable to crack right across the centre—to its utter destruction—as commonly occurs when the latter are accidentally let fall, and more particularly as permitting, in the case of very delicate or friable sections, that the section be finished upon the slide itself, without the necessity of any subsequent removal, as already recommended in ordinary cases. In such cases, in order to prevent the slide being scratched when grinding, it is only requisite to cement to each of its four corners a small piece of thin microscopic cover-glass or of sheet-zinc previous to commencing; these corners—which likewise ensure that the section is ground more flat and uniform in thickness—are removed after the operation.

Hard rocks are, as a rule, easier to prepare than soft or porous ones, which latter should first be soaked in turpentine, then in soft Canada balsam, and afterwards heated until quite hard. Rocks containing minerals of very different degrees of hardness, as, for example, quartz with calcite, &c., should be ground very carefully and slowly upon a close-grained stone or plate, so that whilst the hardest parts are being ground down the soft ones may not be worn away or destroyed at a greater rate.

The thickness of such rock sections must naturally vary greatly, according as the mineral components of the rock itself are more or less opaque; some of the more compact and opaque rocks necessitate sections not more than $\frac{1}{1000}$th of an inch in thickness, but ordinarily one-tenth of this, or $\frac{1}{100}$th of an inch, is sufficient, and in some cases no more than a quarter of this latter thickness is required.

XII.—*On the Markings on the Pleurosigma angulatum and on the Lepisma saccharina.* By J. B. Dancer, F.R.A.S.*

Whilst engaged in testing an object-glass on some injured valves of the *Pleurosigma angulatum*, I noticed a set of faint transverse lines on those portions of a valve from which the ordinary diagonal markings had been removed by abrasion. These transverse lines occupied the same positions on the valves as the ordinary ones, which are visible in perfect valves when oblique illumination is thrown in the direction of the length of the valve. The covering-glass of the slide had been cracked by rough usage, causing the partial destruction of the diatoms. At first it appeared probable that these were spurious lines, caused by moisture, which might have gained access to the valves through the crack in the covering-glass (such as had been noticed by Mr. Hunt, of Birmingham, and described by him in the 'Quarterly Journal of Microscopical Science,' vol. iii.). The slide was carefully dried by heat, and the lines were as visible as before. Repeated observations appeared to prove that these faint lines really exist on the valves. There is little doubt but that the ordinary diagonal markings are on the outside, or convex surface of the diatoms, and in the specimens under examination the broken-up portions of the markings were scattered over the surface of the object. To account for the perfect preservation of the faint lines, I would suggest that they are on the under, or concave, surface of the valve. The lines are visible by oblique illumination, or with the achromatic condenser and central stop. Microscopists are sometimes forgetful that thin and diaphanous objects have two sides; I am reminded of a case in point: some thirty years back the scales of the *Lepisma saccharina* were favourite test objects. The scales are very various in form, according to the position they occupy on the body of the insect; some of the scales have a series of parallel lines running the whole length, which are frequently crossed by lines radiating from the point where the scale is attached to the insect. At the period named I was in the habit of frequently mounting Lepisma scales as objects for the microscope; if too much pressure was applied in transferring the scales from the body of the insect to the glass slide, one set of these lines was rubbed off. It thus became clear that the parallel lines were on one surface and the radiating ones on the other. About the year 1844 I exhibited the scales of the Lepisma in this condition, and gave this explanation to the late Sir David Brewster, who was on a visit to this town. Since then the late

* Paper read before the Microscopical Section of the Manchester Literary and Philosophical Society, March 1st.

Mr. R. Beck corroborated this view of the Lepisma scale by means of the binocular microscope. It is quite possible that the markings seen on other diatoms than the Angulatum may not all be on one surface. The markings on diatoms, and especially those on the *P. angulatum* have been the subjects of much discussion amongst microscopists. At the present time differences of opinion exist on this point.

NEW BOOKS WITH SHORT NOTICES.

Transactions of the Linnean Society of London. Vol. xxvi. Part Second. London: Taylor and Francis.—This part is entirely occupied by Mr. G. S. Brady's splendid 'Monograph of the recent British Ostracoda.' The account of these Crustacea which Mr. Brady has given extends over nearly 150 pages 4to, and is accompanied by fifteen 4to plates containing each an average of fifty beautifully drawn figures. He adopts Sar's method of classifying the Ostracoda, and divides them, therefore, into (1) those in which the lower antennæ are two-branched, and (2) those in which they are single. The former are again sub-divided into those (*a*) in which one branch is rudimentary; those (*b*) in which both are developed and natatory; and those (*c*) in which both are flattened. The first division he terms *Podocopa*, and the three others *Myodocopa*, *Cladocopa*, and *Platycopa* respectively. He gives the following typical areas of distribution:—1. The Arctic type, including all species which attain their greatest development north of the isothermal line of 32° Fahr. 2. The Scandinavian type, comprehending the seas of Iceland, Norway, Sweden, Denmark, Shetland, and Northern Scotland. 3. The British type, including the species distributed pretty generally in the seas of Great Britain. 4. The Atlantic type, including the species which reach their greatest luxuriance on the south and south-western shores of England and Ireland. 5. The Mediterranean type, including species which attain their maximum development in the Mediterranean. He admits that this scheme is imperfect, but considers it better than none at all. As to the manipulation of these animals, and their preparation for the microscope, Mr. Brady states, "It is seldom that much difficulty will be experienced in separating the valves by means of fine needles, and then detaching the contained animal; the various organs are rendered much more distinct by immersion for a short time in a solution of potash, by which the oleaginous and granular constituents are to a great extent removed, the chitinous structures remaining unaffected. If it be desired to mount permanently the dissection thus made, the best medium for the purpose is a compound of glycerine and gelatine, with a slight addition of arsenic," the formula for which is given in Dr. Carpenter's treatise on the Microscope (3rd edition, p. 775). The depths at which certain species have been dredged are generally stated, and an useful bibliography is appended. This monograph of Mr. Brady's affords a fine field for the microscopist in search of work.

Das Hemmungsnervensystem des Herzens Ein vergleichend physiologische Studie, von Dr. Adolph Bernhard Meyer. Berlin: Hirschwald, 1869.—This is a very important report of a great number of experiments in reference to the innervation of the heart, and the

series of phenomena which are coincident with the arrest of the heart's action. It relates not merely to experiments and inquiries upon the heart of Mammalia, but includes a series of valuable researches on the heart of Birds, Reptiles, and Fishes. The Bibliography includes the titles of papers on this subject, written between the years 1842 and 1867 inclusive. The work deserves the attention of those who are interested in Brown Séquard's experiments.

Handbuch der systematischen Anatomie des Menschen, von Dr. J. Henle. Braunschweig: Vieweg und Sohn, 1868.—Though the treatise of the Göttingen Professor is one which for the most part concerns the ordinary anatomy of the human body, it is worth notice by the microscopical anatomist, from its excellent account of those minute and difficult-to-discern structures—the Lymphatics. The woodcuts illustrating the anatomy of the body, though they are intercalated with the text, have been executed by the new process of double blocks, and hence the arteries and veins are coloured. It would be well if some English publisher would give us an anatomical work illustrated in a similar manner.

The Anatomical Memoirs of John Goodsir, F.R.S., late Professor of Anatomy in the University of Edinburgh. Edited by W. Turner, M.B. Vol. II. Edinburgh: Black, 1868.—Although the publishers of this important work have not favoured us with a copy, we cannot, in the interest of our readers, omit giving some account of its contents. The following papers, which are reprinted in the volume, are of especial interest to microscopists:—"The Origin and Development of the Pulps and Sacs of the Human Teeth;" "The Follicular Stage of Dentition in Ruminants;" "The Suprarenal, Thymus and Thyroid Glands;" "The Morphological Relations of the Nervous System in the Annulose and Vertebrate Types;" "Lectures on the Retina;" "The Lamina Spiralis of the Cochlea;" "The Conferva which vegetates on the Skin of Gold Fish;" "The Structure of the Intestinal Villi;" "The Testis and its Secretion in Decapodous Crustaceans;" "The Structure of the Serous Membranes;" "Structure and Pathology of the Liver and Kidney;" "Structure of the Lymphatic Glands;" "Structure of the Placenta and Structure of Bone;" "Mode of Reproduction of lost Parts in the Crustacea;" "The Anatomy and Development of the Cystic Entozoa." The plates which accompany the volume are about twelve in number, and are simple but well drawn.

Untersuchungen über die erste Anlage des Wirbelthierleibes, von Wilhelm His. Leipzig: Vogel, 1868.—In this magnificent 4to, Professor His gives us a monograph in no way inferior to the great work of Von Bär, and certainly the finest thing of the kind that any language has produced since the Russian anatomist published his splendid "Epistola De ovi Mammalium." To do anything more in the space at our disposal than announce the publication of a volume of this kind, which extends over nearly 250 pages, would

be out of the question. Suffice it to say, the author deals with the whole question of the development of the ovum, and that to the reliable results of his own prolonged labours he adds the light thrown by all recent research on his subject. The twelve exquisitely drawn folding plates which are appended to the work are, we affirm without hesitation, the most luxurious examples of lithography that we have ever seen. There are a softness of touch and a naturalness of delineation about them which give them an unusual degree of fidelity as representations of microscopic structure.

Die Borstenwürmer [*Annelida Chætopoda*] *nach systematischen und anatomischen untersuchungen*, von Ernst Ehlers, M.D. Erster Band, mit xxiv Tafeln. Leipzig: W. Engelmann, 1868.—So much controversy has taken place within the last few years between MM. Quatrefages and Claparède relative to these worms, and so much work has been of late done in this branch of zoology, that all will be glad to have so good a treatise as that of Ehlers which is now before us. It seems to us that the author has been liberally just to his fellows in the field he cultivates; and we think, too, that he has given a great deal of useful attention not merely to outward forms of the worms and their appendages, but to their internal anatomy. Frequent reference is made by him to the memoirs of the two naturalists we have mentioned, and also to those of Johnston, Baird, Malmgren, Mecznikoff, Kinberg, Agassiz, Hensen, Hasse, Peters, Siebold, Loven, Engelmann, and others. The plates in this the second division of Ehlers' work are twelve in number, and are extremely well executed.

PROGRESS OF MICROSCOPICAL SCIENCE.

On the Ciliary Muscle in the Domestic Mammalia.—A valuable paper on the anatomy of this organ, by Herr W. Flemming, appears in the last part of volume iv. of Max Schultze's '*Archiv für Mikroskopische Anatomie.*' He has examined this much-disputed structure in the following domestic animals: cats, dogs, pigs, horses, oxen, sheep, rabbits, and rats. He finds that in all these animals the real points of attachment are to the choroid behind, to the sclerotic and cornea in front, and some less certain to the iris. The anterior attachment is certainly not an "elastic" one, as Levy takes it to be, but an unyielding one; for the muscular fibres are attached partly to the sclerotic and partly to the *ligamentum pectinatum*, which consists of inelastic connective tissue. This attachment must be indisputably regarded as its fixed point or origin, so that the muscle fully deserves the name of *tensor choroidei.* In the cat and the dog the iris is acted on by this muscle so as to have its circumference drawn backwards by it. This is

hardly evident in the other mammalia, because of the position, attachment, and the course of the fibres of the muscle. A sphincter action may perhaps be exercised by those fasciculi running transversely, or partly so, to the longitudinal tracts; but from their weakness it must be very slight. Whether, and if so, how, the muscle acts on the ciliary processes is hardly to be determined by purely anatomical research. That in the dog and the cat, if it cannot move them it may alter their form, is not to be gainsaid; but in the ruminants and solidungula it lies so far behind the ciliary processes, and its fibres take such a course, that a direct movement of the processes is in any case not to be thought of. Most important of all, Herr Flemming has found that by the action of the ciliary muscle the attachment of the zonula to the ciliary processes can be displaced backwards and forwards.

The Comparative Histology of the type Mollusca is the title of a memoir by Herr Franz Boll, which forms a supplementary part to the fourth volume of Max Shultze's '*Archiv für Mikroskopische Anatomie*.'

Structure of the Cortical Layer of the Brain of Man.—A second memoir on this subject, by Herr Dr. Rudolf Arndt, is contained in the last number of Max Schultze's '*Archiv für Mikroskopische Anatomie*,' illustrated by two plates. It extends over 120 pages, but is thus summarized by the author:—(1.) The blood-vessels of the cortex cerebri, like those of the entire hemisphere, develop from fusiform cells, which are quite independent of the true nervous elements. (2.) According as the vessels have been formed earlier or later they are non-ramified or ramified. The minute vessels which in the adult pass through the cortex undivided, and only ramify when in the medullary layer, are the earliest formed vessels in the cerebral hemisphere, while all ramifying vessels of later stages of development belong frequently to the period after birth. (3.) The pia mater is not developed till a relatively later period (from the blood-vessels apparently), and from it are derived the connective-tissue corpuscles which can be unmistakably recognized as such in the cortical layer. (4.) The increase of the cortex cerebri itself takes place by the growth of the elements of the terminal fibrous plexus.

On Unstriped Muscular Fibres. — By employing a very dilute solution of chromic acid (0·02 per cent.), Herr Dr. G. Schwalbe has succeeded in isolating unstriped muscular fibres, with their finer details of structure preserved in such perfection as cannot be done by the use of any other of the known reagents. Dr. Schwalbe has more especially examined muscular fibres prepared in this way from the bladder of the dog, as being not only of large size, but easily separable by the above solution. Three principal parts are readily distinguished in every isolated fibre. (1.) One, or generally *two nuclei*, with one or two nucleoli to each. (2.) A not inconsiderable mass of *protoplasm* accumulated about the nuclei. (3.) The *contractile substance*. The usual representation of the nucleus, as staff-shaped, is not correct. In the fresh state it has a faintly-defined outline, is *transparent, ellipsoidal*, and has no granular contents. It can be seen thus, for example, in the bladder of the frog, immersed in its own urine

without removing the epithelium. If the fluid is allowed to act longer on it, it penetrates the epithelium, and causes the muscle-nucleus to shrivel and assume the well-known staff-like shape. The primitive form of the nucleus is also very well preserved in the weak chromic acid solution. For further particulars we refer our readers to the interesting paper itself, which is to be found in the concluding part of the fourth volume of Max Schultze's '*Archiv für Mikroskopische Anatomie*.'

The Ampullæ, or Mucus Canals of the Selachia, have been re-examined by Herr Franz Boll. They are called by the author Lorenzinian Ampullæ, after their discoverer Lorenzini, to distinguish them from the ampullæ of the organs of hearing.—Max Schultze's *Archiv für Mikroskopische Anatomie*, vol. iv., part 4.

Siebold and Kölliker's Zeitschrift für Wissenschaftliche Zoologie.—The last number of this Journal contains the following memoirs.—I. By Professor E. Claparède—Studies on the Acarina: (1.) Contributions to the Knowledge of the Comparative Anatomy and Development of the genus Atax. (2.) On the Development of the genus Tetranydrus. (3.) On the Development of Tyroglyphus. (4.) On the genus Hypopus (Dugès), as a male form of some Tyroglyphi. (5.) On the Development of Hoplophorus. (6.) On the Anatomy and Development of *Myobia musculi* (*Pediculus muris musculi*, Schrank; *Myobia coarctata*, Heyden). (7.) On *Myocoptes musculinus* (*Dermaleichus musculinus*, Koch). (8.) "Für Darwin," Considerations on the Claws of some Acarides. II. By Herrn Fritz Ratzel and Dr. M. Warschawsky—On the Development of the Earth-worm (*Lubricus agricola*, Hoffm.). III. By Herr Dr. Fritz Ratzel, of Carlsruhe—Contributions to the Anatomical and Systematic Knowledge of the Oligochæta.

On Ciliary Motion.—A memoir of 178 pages by Herr Th. W. Engelmann on this subject is to be found in the 'Jenaische Zeitschrift für Medicin und Natur Wissenschaft.' It includes the description of a gas-chamber for microscopical investigations, by which the action of different gases upon an object under the microscope can be observed. The gas-chamber allows of the electric current being passed through the object in the different gases; it can be used with the highest powers, and can be applied at once to any microscope.

On the Blood and other Suspension-fluids.—Herr Alexis Schlarewsky, of Moscow, has contributed a paper to Pflüger's '*Archiv für Physiologie*' on the phenomena observed during the flow of blood, or analogous compound fluids, or artificial mixtures of liquids and solid particles through capillary tubes; and another paper to the same, entitled "On the Extravasation of the White Corpuscles."

Researches with the Microspectroscope, in Pflüger's '*Archiv für Physiologie*,' by Herr S. Stricker, contains nothing of moment which has not already been worked out by Sorby.

Microscopic Examination of the Vesuvian Lava of 1868.—Herr Felix Kreutz has made a microscopic investigation of the lava which flowed from Vesuvius during the eruption in October last. Besides

leucite, a small quantity of vitreous base and minute microlites, he distinguished augite, monoclinic, and triclinic feldspar, biotite, magnetite, and nepheline. A remarkable appearance was the presence of crystals having hexagonal and sixsided outlines, which might be taken for mica, but which from the results of measurements made of them must be regarded as sanidine. The leucite presented fissures in the interior of its crystals regularly arranged, like those to be seen in crystals artificially formed from solution. — *Paper read before the Vienna Academy, February 4th.*

Two New Species of Sponges of the Family Lophospongiæ have been recorded by MM. J. A. Herklots and W. Marshall. This sponge, which has been in the Museum of Leyden for the last three years, has been compared by the naturalists mentioned with *Hyalonema* and *Euplectella*, and is regarded as a new form, under the name of *Hyalothauma Ludekingi*. It was found near the Isle of Ceram, at a very great depth, and it would have been described long since but for the ill-health of one of these naturalists. Some of the provisional descriptions of *Hyalonema Schultzei* by M. Semper lead them to think he has described their species, but others force them to a different opinion. Indeed, they say that M. Semper himself, who has seen the specimen, can neither affirm nor deny its identity with *H. Schultzei*. The new sponge is of regular form, elongated into a pentagonal prism, wider towards the free mouth, attached to the sea-bottom by siliceous threads, which form a sort of root. These threads are united into a multitude of bundles, which anastomose freely with each other, and are continued into the interior of the sponge, there constituting the solid framework of the fibrous tissues. The latter are different in structure. In the interior a tissue of strong fibres interposes itself between the longitudinal bundles referred to, and forms the walls of large canals. On the exterior there is seen, near the free mouth, a tissue of serrated texture, perforated irregularly with large lacunæ; these lacunæ open into the canals which admit the water, and many of them sometimes open into the same canal. In the body of the sponge is seen a regular network, with square meshes formed of cruciform spicules, in which are placed verticillate spicules which form a "whorl." In this firm network may be seen plates of a larger tissue; they are oval in form, and are often disposed in vertical rows. A border of serrated spicules surrounds these plates, and all the openings of the same plate lead to the same canal.—*Archives Néerlandaises des Sciences*, tome iii., livraison 5.

The Structure of the Pistil is continued by M. Van Tieghem in the number just out of the '*Annales des Sciences*' (Botanical part). The paper contains numerous plates, and shall be more fully abstracted in our next number.

The Curves produced in the Movement of Buds is a most interesting paper just begun by M. Ed. Prillieux in the same number. It treats of points inquired into by Herr Hofmeister.

The Fecundation of Ferns is a paper also in this number, by M. Ed. Strasburger.

Reproduction of Limbs.—M. Philippeaux has proved for fish what he had already demonstrated in the case of newts, *viz.* that when the limb is removed below the scapula or ilium it is reproduced. But when the scapula or ilium is removed, no reproduction takes place.—*Comptes Rendus*, March 15th.

Pebrine Corpuscles in Silkworms' Eggs.—M. Cornaillat, who sent a paper on this subject which was read before the *Academie des Sciences* on the 15th ult., states that he has proved three points:—1. That by establishing new centres of cultivation the disease may be checked. 2. That the eggs resulting from the union of a "corpuscular" male and a healthy female are nevertheless sound. 3. That the ratio of corpuscles in the mother and the ovum are as 10 to 1.

Enchondroma in an Ox.—At a recent sitting of the Vienna Academy of Sciences, Herr Rokitansky exhibited a specimen of this tumour in the skull of an ox. The tumour was remarkable for its great size, and for its texture, which was as hard as iron.

Development of the Antheridia in Sphagnum is the title of an instructive paper, read before the Academy of Sciences, Vienna, by Professor Dr. H. Leitgeb, on the 11th of March, 1869.

The Bulbous portion of the Arteries of the Placenta, formed the subject of a paper read at the same meeting by Professor Hyrtl.

The Structure of Tendons.—M. Ranvier, who has been examining the structure of tendons, first stains them with ammoniacal solution of carmine, then washes with water, and finally acts on them with acetic acid. By this means he has been able to recognize—what no doubt represents the yellow, elastic element—a series of deeply-stained lines, which he says are bordered by a distinct envelope, and follow the longitudinal direction. He thinks that collectively the tendon consists of three parts:—First, of an epithelial layer; then of a portion of connective tissue, with large stellate cells; and, finally, of the true tendon-tissue, such as is described above.—*L'Institut*, March 3rd.

The Colour-reaction of Lichens.—Dr. Lauder Lindsay controverts the opinion of Dr. Nylander and Mr. Leighton, that colour-reaction is a specific test of Lichens. In a paper read before the Botanical Society of Edinburgh, on the 11th of February, he stated the following conclusions:—1. The same specimen, in the hands of the same operator, in its different parts, at different times, frequently exhibits colour-reactions different at least in degree. 2. The same species, in the hands of the same operator, and, still more so, in those of different experimenters, in different specimens from the same or different localities, differing in freshness of collection or age, occurring in different varieties of forms, or in different conditions of growth (fertile or sterile, hypertrophied or degenerated), frequently shows colour-reactions differing equally in kind and degree. 3. Colorific quality is determined by circumstances (not fully understood) connected with (*a*) locality of growth in relation to climatic, geographical, topographical, geological, or other conditions; (*b*) states of development, in relation to sterility, hypertrophy, or degeneration of the vegetable tissues proper. 4. This inconstancy of colorific property leads the orchil manufacturer never

to depend on laboratory testings in the purchase of his "orchella weed," or in determining its commercial value; for it not unfrequently happens that a most promising *Roccella* even proves worthless, and is, as such, cast aside. 5. Colour-reaction, though interesting in itself in connection with the general subject of lichen colorific or colouring matters, affords *no aid that can be depended on*, either (*a*) to the systematist in defining species, or (*b*) to the dye-manufacturer in determining the value of his "orchella weed."

NOTES AND MEMORANDA.

Erratum in No. II. of this Journal.—Through a slip of the pen, to which even the most precise writer is liable, the translator of the paper by M. Lacaze-Duthiers in the February number of the Journal, wrote of the supra as the sub-œsophagal ganglion. We ought to apologize to the intelligence of our readers for pointing out a mistake of this kind, as the ganglion in question is throughout spoken of as the *dorsal* or *superior* one, thus leaving no doubt as to the meaning of the context. But as we desire to be exact, and as we have a wholesome remembrance of the fantastic tricks of the "printer's devils" in the old journal, we call attention to what was certainly an error. We may mention also that we will esteem it a favour if our correspondents will point out the errata they may observe in our pages. We strive after accuracy, but we are by no means infallible.

A New Form of Condenser, which is we believe—we have not yet had the pleasure of seeing it—a modification of that known as Mr. Reade's Kettle-drum, has been devised by Messrs. Powell and Lealand. We are informed that it is especially valuable in the examination of Diatomaceæ.

Mr. Ross' Compressorium.—Mr. Ross has made some improvements in his compressorium, which render it a suitable apparatus for research on specimens, such as infusoria and rotifers. The double inclined plane principle, worked by a finely graduated screw, which brings the two surfaces of the glasses together with any degree of slowness and compression, seems to work well. We had hoped to have placed a figure of this accessory before our readers, but owing to the engraver not having had the block cut in time we must defer a further account to our next number.

The Provincial Microscopical Societies.—We are now in communication with most of the local Associations, and we hope ere long to cement relations with all. In the meantime, we shall feel obliged for any notices or notes that our correspondents can find time to send us. We desire to represent fairly and fully the labours of all British Microscopists.

Dr. Bastian's Cement.—In reply to our correspondent, G. F., we may state that this cement, which will be found very useful by those

engaged in mounting specimens, and who have not much time to spare, can be had from Mr. Ladd, of Beak Street, Regent Street.

Spores in the Air.—The problem of panspermy can be put to the test by all who have got good microscopes. It is only necessary, as explained in M. Pennetier's book, noticed in our last number, to submit a series of glass-slides, covered with glycerine, to a current of air drawn by a force-pump, or by other means caused to impinge on the glass. An examination of the slides with powers of from $\frac{1}{5}$ to $\frac{1}{8}$ will then in great measure decide the question. It would be interesting to contrast the air of dry with that of marshy localities.

Bacteria in Plants.—It is alleged by certain French observers of note, that the pulp of plants, even when fresh, contains bacteria in considerable quantities. Will some of our readers investigate this matter, and give us the results of their labours.

The Green-colouring Matter of Trochœta Sub-viridis.—Dr. Baird kindly submitted to us some of the green-colouring matter obtained by keeping this leach in spirit. Mindful of Schultze's observations, we examined it with the spectroscope, but failed to find anything like a "characteristic spectrum." There was considerable absorption of the violet and partly of the green, but no band was to be found. We shall be glad to know whether any of our readers have obtained different results.

Deep Sea-dredgings.—In a paper read before the Botanical Society of Edinburgh, Professor Dickie described his mode of examining a number of Foraminifera, from a depth of 2000 fathoms, immediately under the Gulf Stream. He tested them with weak acid, and finding a large residuum of sarcode, he concluded that they had been living at this depth.

The New Half-inch Object-glass.—In our last number we referred to an excellent glass of this kind, since presented to the Society, and manufactured by Mr. Collins. In doing so, we referred to the fact that Messrs. Powell and Lealand had been the first to make such an objective. It would seem, however, that some of our readers gathered from the note, that Messrs. Powell and Lealand had given up the manufacture of these glasses, and this eminent and much respected firm consider that the impression thus created was calculated to do them an injury. We, therefore, beg to state that Messrs. Powell and Lealand still make such glasses, and it needs no comment of ours to assure microscopists that these opticians have never turned out anything but work of the very highest quality and perfection.

The Nervous System of the Slug.—Our correspondent, J. Daly, should communicate with M. Lacaze-Duthiers. We ourselves [Ed. M. M. J.] have described * four pairs of nerves as proceeding from the supra-œsophagal ganglion; but we certainly defer to the opinion of so high an authority as the French anatomist.

* "The General Anatomy of *Limax maximus*."—'Quart. Jour. Micros. Science,' January, 1863.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.†

King's College, 10*th March*, 1869.

The President (Rev. J. B. Reade, M.A., F.R.S.), in the chair.—The minutes of the last meeting were read and confirmed.—List of donations which had been made to the Society was read, and vote of thanks unanimously passed to the donors, especially to Mrs. Clark of Whitby. Mr. H. J. Slack informed the meeting that a new ½-inch object-glass had been presented to the Society by Mr. Collins. The Fellows would remember Dr. Carpenter's recommendation of a ½-inch object-glass with an angle of aperture of only 30°, for use with the binocular microscope. Dr. Carpenter stated that a glass of this description made for him by Messrs. Powell and Lealand, gave a true perspective view of objects examined, and Mr. Collins had constructed the glass he now presented to the Society in conformity with this opinion. A vote of thanks was passed to Mr. Collins.—Notice was given that two Fellows were to be balloted for.—The President proposed the re-admission of Professor Simonds into the Society, upon the condition of his paying the subscription under the new bye-law, of 2*l*. 2*s*. per annum, remitting the entrance fees, on the ground of his having previously been a Fellow of the Society.—Mr. H. J. Slack read a short description by Mr. F. Blankley, of a new Selenite stage which was exhibited to the meeting.—Mr. Suffolk dscribed and gave a description of the new Growing-slide described by Mr. Muller on page 174 of this Journal. The thanks of the meeting were given to Mr. Suffolk for his explanations.

Messrs. R. and J. Beck exhibited their popular microscope, with a new movable stage, working very smoothly upon a glass plate.

Mr. Davison of Glasgow exhibited a No. 6 eye-piece, of Hartnack's make, and explained its construction to be a modification of the Coddington lens.

Mr. Browning remarked that solid eye-pieces had been in use for some time with telescopes, and possessed certain advantages.

The President mentioned his having used such eye-pieces several years back.

Mr. Ince then read a paper of Professor Gulliver's, "On the Fibres of the Crystalline Lens."

Dr. Murie was understood to say that no one was more competent to speak on the subject of the paper than Professor Gulliver. He did not, however, agree with him in the inference which he had

* Secretaries of Societies will greatly oblige us by writing out their reports legibly—especially the technical terms—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

† Report supplied by the Secretaries.

drawn. He did not agree with the statement of the Professor, that the characteristic affinities of animals could be distinguished by the fineness of the fibres of the Crystalline lens. With regard to the classification of animals, the tendency of the present d ıy was too much to run upon a single character.

Dr. Lawson made some observations on the remarks of Dr. Murie and on Professor Gulliver's paper.

The President said:—It was a question whether Professor Gulliver was correct in stating that the edges of the fibres of the lamprey are absolutely smooth. Sir D. Brewster had stated, that when he was examining the Crystalline lens, it was an unquestionable fact, that in fibres of fishes teeth existed to a very great extent; yet he doubted the existence of teeth in the edges of the fibres of Mammalia. Afterwards, however, by means of a better illumination, he was able to see the teeth by the aid of the phenomena of polarized light. Professor Gulliver has not alluded to these phenomena, and it is probable that he may not have seen them. The form of the lens in fishes is generally a prolate spheroid, the fibres converging from the Equator to the Poles. The thickness and breadth of the fibres which Professor Gulliver has given is probably correct. In the case of the cod, Sir D. Brewster gives the breadth of the fibres as the 5500th part of an inch; in each fibre there are 12,500 teeth; in the lens there are 5,000,000 fibres; consequently there are 62,500,000,000 teeth in the fibres of the lens of a cod. Then with respect to the action of polarized light, it is very remarkable that in the lens of fishes we have the concentric circles of light, separated by two concentric dark circles (the circles being very faint on the outer portion of the lens), and the whole intersected by a black cross. Sir D. Brewster observed also a remarkable variation of density—the concentric circles in the nucleus and the outer portion of the lens being negatively polarized, and the intermediate portion being positively polarized. In animals, however, the nucleus and the outer portion have positive double refraction, while the double refraction of the intervening structure is negative—a result exactly contrary to that exhibited in fishes. Sir David says, the varying density—that is, the increase of density from the surface to the centre of the lens—is probably intended to correct spherical observation. Of the other properties of the structure Sir David Brewster says, they have not even excited the "ingenuity of conjecture." The subject is highly interesting, and there is a wide field open to the Fellows of the Society for investigation.

Mr. Alfred Sanders then read a paper "On the Zoosperms of Crustacea."

A vote of thanks was passed to Mr. Sanders.

The President announced that the next meeting will take place on the 14th April, when papers will be read by Dr Lionel Beale "On Protoplasm and Living Matter;" and by Mr. Suffolk "On the Proboscis of the Blowfly," illustrated by the valuable drawing which had been submitted to the Fellows.

The Meeting of the Fellows was adjourned to the 14th April.

Donations to the Library and Cabinet, March 10, 1869:—

	From
Land and Water. Weekly	*Editor.*
Scientific Opinion. Weekly	*Editor.*
Society of Arts' Journal. Weekly	*Society.*
Quarterly Journal of Geological Society	*Society.*
The Student	*Publisher.*
Mémoires de l'Académie Impériale de St. Pétersbourg, Nos. 3 and 17	*Author.*
The Caudal Heart of the Eel a Lymphatic Heart. By T. W. Jones, F.R.S.	*Author.*
¼-inch Object-glass	*Mr. Chas. Collins.*
One dozen Slides of Polyzoaries, &c.	*Fleetwood Shrapnel, Esq.*
Ten Slides of the Fructification of Seaweeds	*Mrs. Clark.*
Two Slides of Bone Sections	*Rev. T. H. Browne.*

The following gentlemen were duly elected Fellows of the Society:—

The Rev. Chas. Hope Robertson, M.A.
Henry Syme Redpath, Esq.; and
James Beart Simonds was re-elected.

WALTER W. REEVES,
Assist. Secretary.

QUEKETT MICROSCOPICAL CLUB.*

At the meeting, held at University College, February 26th, Arthur E. Durham, Esq., F.L.S., &c., President, in the chair,—ten new members were elected, and ten gentlemen were proposed for membership. Amongst the presents to the library and cabinet, it was announced that through the influence of the Rev. H. S. Bold, one of the foreign correspondents of the club, a number of valuable photo-micrographs had been received from the Surgeon-General of the Army Medical Department at Washington, to whom a unanimous vote of thanks was passed.

A paper was read by Mr. James Jordan, "On the Preparation of Rock Sections for Microscopical Examination," in the course of which he described a new form of machine for the purpose, having a 2-feet driving-wheel and a slitting-plate of soft iron, charged on the edge with diamond powder. Provision was made for regulating the thickness of the slice and varying the pressure, whilst the polishing was performed upon a leaden lap similarly mounted. The construction of the apparatus was explained by the aid of diagrams; and a number of specimens of rock sections in various stages of preparation were placed upon the table for examination. After a few remarks by the President, a discussion took place, in which Messrs. Breese, Slade, Curteis, and the author of the paper took part. Mr. M. C. Cooke then read a paper "On Bunt Spores," describing their general characteristics and variations, briefly reviewing the different observations made upon them since 1848, and critically examining the evidence as to their supposed connection with the cholera epidemic. The paper

* Report supplied ' ". Lewis.

was illustrated by diagrams and by specimens of bunted wheat, and a vote of thanks to the author was unanimously carried.

Mr. H. F. Hailes exhibited and described a new porcelain shade for microscope lamps, which appeared to possess many advantages over most of the shades in common use. It was said to be applicable to any lamp, and whilst perfectly screening extraneous light from the eyes of the observer and from the room generally, it threw no shade upon the table, and did not become too hot to be raised or removed at any time by the fingers. Mr. W. Moginie also introduced to the notice of the club a new portable collecting case, fitted with three large and four small bottles, a ring for attaching them to a stick, a cutting-hook, and a magnifying lens. In reply to a question from Mr. Golding, the President stated that in consequence of the great success of the monthly conversational meetings, held during the winter, the committee had decided to continue them during the summer months, provided that the requisite permission from the authorities of the College could be obtained. The proceedings terminated with a conversazione, at which, amongst the many objects of interest exhibited, special attention was attracted by a series of very beautiful drawings of Infusoria and Entomostraca, by Messrs. Tatem and Clayton, of Reading, which had been kindly lent by them to Mr. Curties for exhibition to the members of the club.

The Annual Soirée of the club took place at University College, on March 12, the use of the building having been most courteously granted by the Council for the occasion. The library and museum were specially arranged for the exhibition of microscopic objects by the members of the club and the various makers, about 200 microscopes being employed for the purpose. Several of the class-rooms were fitted up as dark chambers, in which were exhibited at intervals microphotographs, polariscope and kaleidoscope effects, dissolving views of Abyssinia, and microscopic and natural history subjects, whilst refreshments were served in two other class-rooms and in the museum. The number of visitors present during the evening was about 1500, who were received on arrival by the President, the Secretary, and a member of the Soirée Committee; and copies of a printed synopsis of objects exhibited, with a plan of the building, were freely distributed. In addition to the numerous microscopes, a number of interesting photographs, collections of stuffed birds, books, drawings, and works of art were placed upon the tables for inspection, and excited considerable interest. Many of the microscopic preparations shown, were of great beauty, but where all were excellent it would seem invidious to make any selections for special notice here.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, January 26th, 1869. R. Angus Smith, Ph.D., F.R.S., Vice-President, in the chair.—"On Microscopical Examination of Dust," by J. B. Dancer, F.R.A.S. The author stated that he had made some microscopical examinations of dust collected in June, July, and August last, and also of the particles contained in the rain-water

after the long drought. He had intended to bring these observations before the Society in a complete form, but has not hitherto found time to do so. He proposed to carry on observations during every month in the year, for the purpose of recording the average amount of solid matter deposited on a given area, and also, as far as possible, to ascertain the character of the deposits. The observations so far have shown, as might have been expected, that the dust in various localities, at different altitudes, and under other varying conditions, contained particles differing in magnitude, appearance, and quantity for the same superficial area. In every instance molecular activity was abundant, but the animal life was very variable in amount, the largest number of moving organisms being in the dust collected at the lowest points— this was about five feet above the surface of the earth. This dust also contained the largest proportion in magnitude and quantity of vegetable matter. These observations also show that in thoroughfares where there are many animals engaged in the traffic, the majority of the light dust which when disturbed, reaches the average height of five feet, or about the level of a foot-passenger's mouth, consists of a large proportion of vegetable matter, which has passed through the stomachs of animals, or which has suffered partial decomposition in some way or other. This is not an agreeable piece of information, but it is a fact. It shows the necessity, in a sanitary point of view, of the streets being well-watered before the scavengers are allowed to commence operations; otherwise the light dust is only made to change its locality and is not properly removed. It is not pleasant to contemplate the possibility of germs of disease being wafted along with this decaying matter, and inhaled by those whose condition might be favourable for its development. The author hopes to bring the details of these observations before the Society at some future time. H. A. Hurst, Esq., read a paper on the "Flora of Gibraltar," in which he remarked on its great richness, comprising, as it does, in an area of about 1½ square mile, 500 plants, being one half of those contained in the Cybele Hibernica, and one-third of the whole number enumerated as growing in the British Islands in the last 'London Catalogue.'

Microscopical and Natural History Section.

February 1st, 1869.—J. B. Dancer, F.R.A.S., President of the Section, in the chair. Dr. Alcock exhibited some objects from Australia, lent to him for the purpose by the Lower Mosley Street Natural History Society. They were presented to that Society by Mr. Albert McDonald, of Pioneer's Rest, on the River Mary, Queensland, and consisted of the skull of a native Australian, and a stone tomahawk which had been found in the ground by a neighbour of his, and at Mr. McDonald's request it had been furnished with a proper native handle by one of the blacks. It was a very interesting specimen, as genuine implements of this kind are now very rare in the country, the use of iron having quite superseded them. He also exhibited some of the ordinary weapons of the natives, a shield made of very light wood and painted by a native artist, two war-clubs or nulla-nullas (aboriginal

name koo thaar), and some boomerangs. He read a few interesting particulars relating to the objects from Mr. Mc Donald's letters.

Mr. G. E. Hunt read a paper, entitled "Notes of the Rarer Mosses of Perthshire and Braemar," of which the following is an abstract:—

Three alpine regions in Scotland stand pre-eminent for the variety of their cryptogamic flora: 1st, Ben Lawers, in Perthshire, with the adjoining peaks; 2nd, the Clova district, in Forfar; 3rd, Braemar. All these were long since searched by able botanists, as Hooker, Gardiner, Drummond, Wilson, Arnott, Greville, and others; but such is their richness, that a year hardly ever passes without some discovery. There are several causes for this richness, *viz.* elevation, moisture of climate, and nature of soil.

Ben Lawers is the highest mountain in Perthshire, and attains an elevation of 3984 feet above the level of the sea—its lower slopes consist of extensive moors, interspersed with peat bogs, which are the favourite abodes of various species of Sphagnum, Splachnum, Dissodon, Bryum, Mnium, and Hypnum. Its upper portion is composed of micaceous schist; there it is that most of the great treasures of the mountain lie concealed — some of the species grow on precipitous ledges of rock, others in deep crevices, and others again on grassy turf. The additions of the last four years to the British flora from this ground are sufficient to attest its richness, *viz.* :—

Tortula fragilis.	Leskia nervosa.
Mnium spinosum.	Hypnum sulcatum.
Timmia megapolitana.	" Bambergeri.

Neither the preceding species nor the following, viz. *Hypnum plicatum*, *H. cirrhosum*, *H. Oakessii*, discovered at dates varying from 1823 to 1850, have yet been found in Britain, elsewhere than on Ben Lawers.

Altogether about 180 species of mosses have been recorded from this mountain; and when those of the woods, rocks, and walls round its base are added, the total of species for the district will amount to about 330.

In Braemar the character of the soil completely changes, and with it the vegetation. The valleys and lower ridges are principally composed of slaty rocks—the higher mountains of the Cairngorm range of granite. In the valley Dr. Dickie has been fortunate enough to discover, on the decayed wood of dead fir-trees, the very rare *Buxbaumia indusiata*, and he gathers the other species, *B. aphylla*, at a somewhat higer level, on *débris*. The moors, streams, and rocks of Glen Callater and Loch Kandor are notable for their rarities, conspicuous among which stand

Andreæa falcata.	Hypnum dilatatum.
Grimmia atrata.	,, arcticum.
Tetraplodon angustatus.	Mielichoferia nitida.

The latter species is specially interesting, from the fact of its having been re-discovered, in 1868, by Messrs. Fergusson and Roy, in the same station when, in 1830, a single tuft had been found by Dr. Greville. The only other British locality is above Ingleby Greenhow, in York-

shire, where Mr. Mudd (now of the Botanic Gardens, Cambridge) collected it in 1862. Ba-mac-dhui, the loftiest of the Cairngorm range, produces several very rare species abundantly, *viz.*:—

Polytrichum sexangulare.	Dicranum arcticum Sch. (D. Starkii β molle Wils).
Audreœa nivalis.	Hypnum molle Dicks.
" grimsulana.	

The last-named species was, until very recently, almost unknown to botanists generally, and is still, as regards its synonomy, enveloped in considerable doubt.

Short as the preceding sketch is, it will suffice to show the great difference between the micaceous mountains of Perthshire and the slaty and granitic ones of Braemar. Either region will richly repay the naturalist who may devote his time to its exploration, whilst the scenery around him must excite his intensest admiration, and of itself will amply repay him for a visit.

Mr. John Watson exhibited upwards of 200 drawings from slides sent by him to Mr. Tuffen West, hereafter to be lithographed with others for his intended treatise on the plumules (so called) of the *Lepidoptera*; they were principally of the *Pieridæ* family, all being drawn by the camera to one magnifying scale of 350 times linear measurement.

He also showed a number of these insects which yield the plumules, and drew attention to their similarities and differences; noticing that some butterflies, closely allied in all other respects, display corresponding but distinctive resemblances in this also, while others as nearly allied possess very different forms of plumule; and that the size of the insect does not govern the size of the plumule, some large species having small plumules, and some small species having large plumules; some striking examples of these facts were exhibited. About thirty species of the insects themselves, with drawings of their own plumules placed by their side, afforded an easy mode of observation of the marvellously varied types of form displayed in these curious scales.

Besides the drawings of the *Pieridæ* family were a few of the *Danaidæ* (genus *Euplœa*) and *Nymphalidæ*, and Mr. Watson expects to exhibit shortly a large number of drawings from these families, and from the *Heliconidæ*, *Satyridæ*, and *Lycænidæ*. He drew attention to some hair-like scales tufted at their apex, which occur on some species of the genus *Argynnis* (to one of which he had previously alluded in his last paper), and showed drawings of them side by side with the true plumules and specimens of the insects themselves, from which both were taken. Whether or not these hair-like scales possess value for the determination of species is at present uncertain, but there can be no doubt of the plumules wherever found in all genera serving for that purpose.

The feathery tip of the plumules is very fragile—more so in some species than in others: slides are often covered with the *débris*; the drawings cannot represent their natural luxuriance in life.

THE MANCHESTER LOWER MOSLEY STREET NATURAL HISTORY SOCIETY.* MICROSCOPIC SECTION.

Minutes of Meeting, 22nd July, 1869. Mr. Chaffers, President, in the chair.—In accordance with the resolution passed at the last meeting, each member brought slides of the *Cricket* or *Cockroach*.

Mr. Aylward, *Gizzard of Cockroach; Head* of ditto, dissected; *Head, Gizzard, Section of Gizzard, Ovipositer, Spiracles, Tracheæ, Tongue and Eggs of Cricket.*

Mr. Jackson, *Legs* and *Wing Case of Cricket, Antennæ of Dytiscus.*

Mr. Chaffers, *Gizzard of Cricket*, two slides; *Legs and Abdomen of Cockroach.*

Mr. Nash, *Elytra* and *Antennæ of Cricket.*

Mr. Armstrong, *Two Cockroaches, mounted entire; Head and Legs of ditto; and Gizzard of Cricket.*

Mr. H. Hyde, *Leg of Cricket.*

Mr. Wilmot, *Gizzard of Cockroach.*

The evening was spent in examining the various specimens, most of which were very well mounted.

Minutes of Meeting, 8th March, 1869. Mr. Chaffers, President, in the chair.—A variety of unmounted objects were distributed amongst the members.

Mr. Armstrong, showing four mounted slides of a very brilliant *Beetle* (name unknown), *viz.* the Head, Elytra, Skin, and Wing.

The following contributions were made to the Society's cabinet:—

Mr. Armstrong, *Elytra of Beetle.*

Mr. Jackson, *Spores of Lastræa filix-mas.*

Mr. Hope, *Wing of White Plume Moth.*

Mr. Armstrong presented two large photographs to the Society, *Pleurosigma formosum* and *Parasite of Field Mouse.*

It was agreed that at the next meeting, 22nd inst., each member should bring a mounted slide or slides of the *Spider* or *House Fly*, with observations upon them.

Mr. Armstrong read a very comprehensive and instructive paper upon the microscope and the various objects open to the study of microscopists, which he illustrated with a large number of photographs of microscopic objects. He stated, There are three essential conditions of efficiency in a microscope: 1st, sufficient visual magnitude; 2nd, sufficient distinctness of delineation; 3rd, sufficient illumination; gave a lucid description of the three essentials; and quoted various appropriate passages from different authors, descriptive of microscopic pursuits, and how innumerable are the objects suitable for the microscopist. He quoted and instanced the *Volvox Globator; Animalculæ* of various kinds; *Water Insects* and *Beetles; Parasites* from *Animals, Birds,* and *Insects; Acari; Spiders;* dissections of Insects and Plants, instancing the various transformations of insect life, showing how interesting is the life history of any of our common insects; naming also for the more advanced microscopist the various

* Report furnished by the Secretary.

anatomical preparations; and showing how beautiful, as objects of studies, are the *Diatomaceæ* and *Desmideæ*, and how truly wonderful is it that in objects so minute there should be so much real beauty and geometrical precision of outline; in conclusion, drawing attention to the various modern appliances and apparatus connected with the microscope.

Microscopical Society of Liverpool.

The second meeting of this Society was held at the Royal Institution, on Tuesday, February 2nd, J. Birkbeck Nevins, Esq., M.D., President, in the chair.

Mr. G. S. Wood (of Messrs. Abraham & Co.'s) exhibited Woodward's "Heliostat," made by his firm after a drawing furnished by Mr. T. Higgin.

The Secretary read a letter from Mr. T. C. White, accompanying a collection of slides of Hippuric Acid, presented by him to the Society.

Messrs. Whalley, Broad, Archer, and Packer were elected members of the Society.

A paper was then read by the Rev. W. Banister, B.A., one of the Vice-Presidents, "On the Microscopical Structure and Development of Ferns." He introduced the subject by showing the importance of this branch of microscopical inquiry, as bearing on the question of the mode of reproduction in cryptogamic plants.

After noticing that the break which it was formerly thought existed in the series between the flowering and non-flowering plants was nearly filled up, he stated that the organs now generally recognized as those of reproduction on the prothallia of ferns, *viz.* the antheridia and archegonia, were analogous in their office to those of flowering plants, the spermatozoa emitted from the antheridia performing the part of the pollen, and fertilizing the germinal vesicle at the base of the archegoniam tube, as the pollen descends the style for the same purpose.

He quoted Hofmeister's statement concerning the Coniferæ, that in more than one respect the formation of the embryo of the Coniferæ is intermediate between the highest Cryptogams and the flowering plants, and that the pollen of the Coniferæ varies in a marked manner from that of other flowering plants, and exhibits *vital phenomena* similar to those of some non-flowering plants.

To show that the mode of reproduction in ferns touches the main system of vegetation in more points than one, he then called attention to the remarkable fact that while in all the higher orders of animals and plants the power of reproduction is not attained till maturity, in ferns the very earliest tissue bears the organs on which continuation of the species depends; and lastly, to the singular paradox, that whilst it is in the lowest forms of animal and vegetable life which are least easily distinguished from each other, a connection exists in the most important function, between a low class of plants and the highest members of the animal kingdoms, *viz.* in the mode of reproduction by motile spermatozoa.

He adopted Hofmeister's view of ˉ ˉ ›rnate generation of ferns,

the prothallium, bearing the sexual organs only, as the first; the true fern, bearing the sporangia or seed vessels, as the second. He then traced the life of a fern spore, and exhibited *in situ* the sporangia of nearly all the British genera, and also of a large number of the most interesting exotic species. The variety in form and size of the spores, the texture of the elastic ring, the scales on the rachis, and the stellate hairs on the pianæ of *Niphobolus lingua*, *Lepicystis sepulta*, *Platycerium alicorna*, &c., formed beautiful objects of illustration. Prothallia, on which the antheridia and archegonia were distinctly visible, were exhibited side by side in a compressorium.

In conclusion, oblique sections of the stems of several ferns were made, and the scalariform tissue contained in the characteristic bundles of ducts in each species was clearly exposed; and it was shown that the structure of the stem did not influence the system of classification adopted by Hooker or Smith, for they class, respectively, *Filix mas*, whose rachis contains two large and three small round bundles of ducts; Smith with *Filix femina*, whose stem contains but *two* somewhat reniform bundles, with their convex sides turned towards each other; and Hooker with *Nephrodium molle*, whose two reniform bundles have their concave sides towards each other.

Some discussion followed the reading of the paper, and after a vote of thanks to Mr. Banister for his interesting paper, the usual conversazione followed.

The third ordinary meeting was held at the Royal Institution, on Tuesday, the 2nd instant, the Rev. W. Banister, B.A., Vice-President, in the chair.—Messrs. G. S. Wood, A. G. Phillips, Henry Fletcher, Charles Love, M. Aronsberg, J. H. Johnson, H. Heap, and Rochfort Connor were admitted as ordinary members. The Rev. W. Banister alluded to the subject of the distribution of the bundles of scalariform ducts in the various species of ferns, and called attention to the fact that in the same plant the number of bundles varies in different parts of the rachis, being more numerous near the base.

The Secretary exhibited a specimen of Physalia, sent by Mr. T. J. Moore. A number of these interesting little creatures had been washed ashore at Southport, near Liverpool, on the 27th February.

Mr. Henderson exhibited a slide of micrographic writing on glass, on which the 2nd chapter of St. John was written in $\frac{1}{2000}$th of an inch.

Mr. Henderson also exhibited the Mexican resurrection plant, *Lycopodium lepidophyllum*.

A paper was read by Mr. W. J. Baker, Hon. Treasurer, "On the Collection and Preparation of the Diatomaceæ."

The meeting terminated with the usual conversazione.

Birmingham Natural History and Microscopical Society.

At the last meeting but one, Mr. W. R. Hughes, F.L.S., read a paper on "Edwardsia Vestita (*Cerianthus Lloydii*, or the Vestlet of Gosse)," an aberrant species of sea anemone. The paper was illustrated by beautiful drawings from life, executed by Mr. G. S. Tye, exhibiting details of structure, and was accompanied by a magnificent

specimen in perfect health (shown with its tube artificially enclosed within, and protected by a glass test-tube) from the aquaria of Mr. Hughes.

At the last meeting, Mr. A. W. Wills (Hon. Secretary to the Society) read a paper "On the Preparation and Mounting of Microscopic Crystals." The author described some very curious and interesting phenomena obtained by the deposition of crystals from very hot solutions hermetically sealed in extremely thin cells, the crystals obtained in this manner being invariably redissolved by the mother liquors more or less completely after the lapse of a time varying from a few minutes to as many hours, but being redeposited on the application of a moderate degree of heat and again recooling, this alteration being capable of indefinite repetition.

Reading Microscopical Society.

16th February, 1869.

Captain Lang, President, in the chair.—Mr. F. Dormont read a paper "On Desmids and Diatoms," in which he discussed the character of their coatings, cell contents, conjugation, movements and markings, referring for illustration to typical forms, of which he exhibited slides.

Several objects of interest were shown by various members: a small and new species of Alga, parasitic on an entomoscracan (exhibited by Mr. Clayton), claiming special attention.

Brighton and Sussex Natural History Society.

March 11th. The President, Mr. Glaisyer, in the chair.—A paper "On Microscopic Fungi" was read by Dr. Hallifax, in which, among other inducements for their study, it was pointed out that, since the microscope had become a more perfect instrument, the number of species had been increased from 400 to between 4000 and 5000, and still many forms were in all probability unknown, as many regions remained unexplored. One circumstance entitled them to the attention of the scientific botanist and microscopist, *viz.* the illustration they offered of the unity which pervaded all organized forms of life, for though so diverse in their characters, their elemental structure was the same; in flowering plants the simple leaf, as was well known, was differentiated into bract, calyx, corolla, &c., so among fungi all parts were resolvable into delicate threads called *Mycelia*, sometimes filamentous in their appearance, at others felted and consolidated into a leathery substance. The ravages they committed among crops on which man and animals depended was another inducement for their study, thus cereals, potatoes, vines, hops, silkworms, &c., had been destroyed by their agency; and many problems respecting their form, propagation, and supposed influences in diseases remained unsolved. Some points had been cleared up, by which what had been thought to be different species or even genera had been shown were only different stages of the same fungus, or differences of form resulting from the *nidus* in which found. Attention was specially directed to those attacking the potato and wheat, and allusion was made to the so-called

Cholera fungus. The paper was well illustrated by microscopic preparations, among which the most striking were—*Peronospora infestans*, or potatoe leaf; *Cladosporium herbarum*, or stone crop; *Stillbum aurantiacum*, or stem of sage; *Aspergillus glaucus*, or leaves of thyme; *Helotium æruginosum*, in oak wood, exhibiting the germination of the spores and section of common membrane.

Bristol Microscopical Society.

Wednesday, 17th March, 1869.

Mr. W. W. Stoddart, F.G.S., F.C.S., President, in the chair.—The minutes of the last meeting were read and confirmed.

Dr. Hudson then proposed the following resolution, which was seconded by Mr. Feddens, Vice-President of the Society, and carried unanimously:—"That at the next meeting of the Society, to be held in April, in place of any paper being read each member shall be requested to bring his microscope, and to exhibit any objects illustrating the special subject he may be engaged in investigating, or any other objects likely to prove interesting to the other members. And that in future two meetings during each session shall be set apart for this purpose."

Dr. Hudson also proposed, seconded by Dr. Fripp, that Kölliker's and Siebold's 'Zeitschrift' should be purchased annually for the Society's library. This proposition was carried unanimously.

Dr. Fripp then read a paper, entitled "Notes on the Minute Anatomy of Brain and Spinal Cord." The paper was illustrated by a number of beautiful microscopical preparations.

Old Change Microscopical Society.*

March 19th, 1869.

The President, Chas. J. Leaf, Esq., F.L.S., F.R.M.S., &c., in the chair.—This was the Annual Meeting of the Society.

The Treasurer's Report showed—

	£	s.	d.
Balance in favour of the Society, March 27th, 1868 ..	20	13	4
Income, 1868–9 (including a balance of 11s. from Soirée)	189	11	5
	210	4	9
Expenditure	196	9	2
Leaving a balance of	£13	15	7
in favour of the Society.			

Messrs. G. T. Brown and C. J. Richardson were re-elected to serve on the Council.

The following donations were announced, and the thanks of the Society awarded to the donors:—

	From
42 Slides	*M. C. Cooke, Esq.*
Monthly Microscopical Journal ..	*The Editor.*

* The Report of the Soirée which took place on the 15th February and was most successful, reached us too late for the March number. It would of course be out of date in the present one.—Ed. M. M. J.

The President then delivered his Annual Address, being a *résumé* of the operations of the Society during the past 12 months.

A vote of thanks, embodying a request that he allow the address to be printed, was unanimously accorded the President.

Votes of thanks to the Treasurer, Council, and the Hon. Sec. were also passed, and responded to by Mr. Thos. Birch, Mr. H. Richardson, and Mr. S. Helm.

A special meeting was announced for April 16, to read papers and examine slides, which had obtained prizes in the recent competition.

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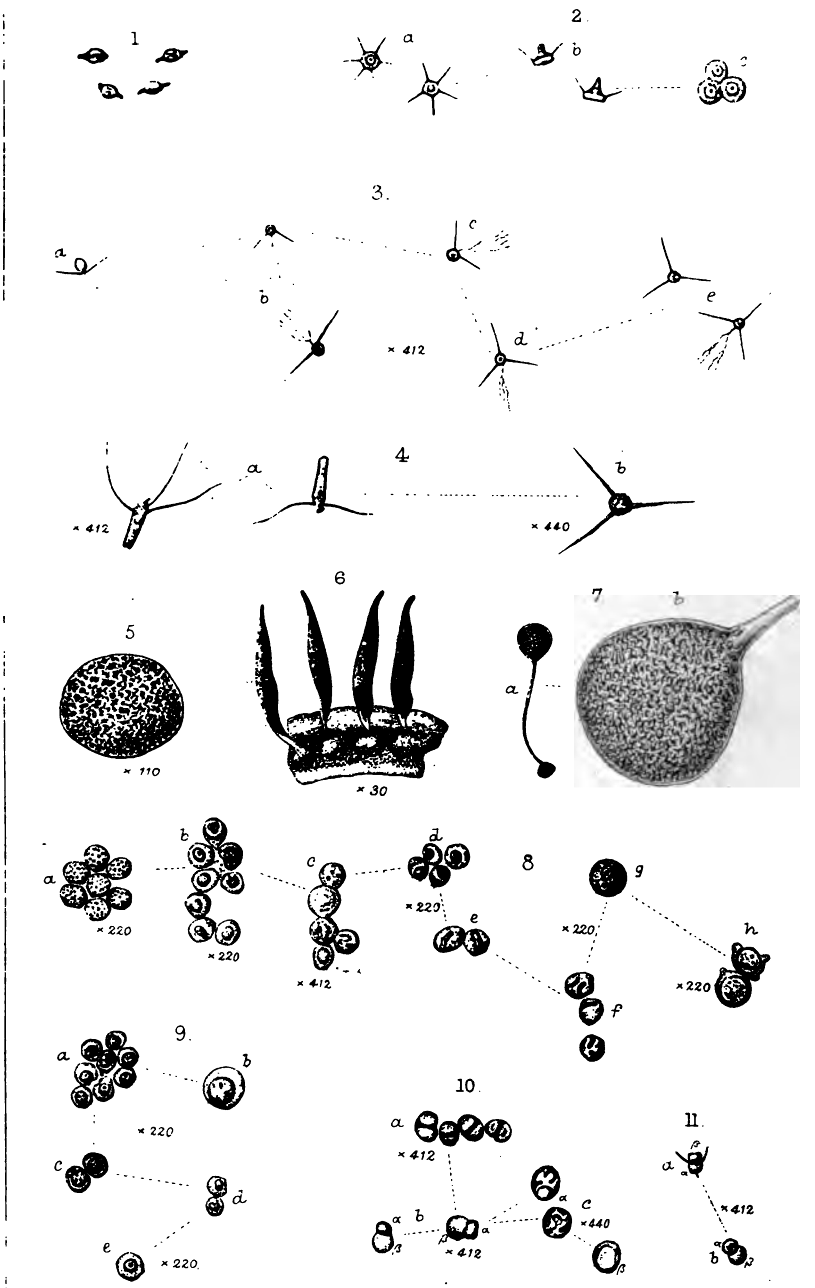

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Crustacean Zoosperms.

THE

MONTHLY MICROSCOPICAL JOURNAL.

MAY 1, 1869.

I.—*Notes on Zoosperms of Crustacea.*

By ALFRED SANDERS, M.R.C.S., F.R.M.S.

(*Read before the* ROYAL MICROSCOPICAL SOCIETY, *March* 10, 1869).

THE higher Crustacea have the peculiarity, which they share with the Arachnida, Myriapoda, and, I believe, a few other animals, of possessing zoosperms distinguishable from those of the remainder of the animal kingdom, by not being linear, and, moreover, by not having that undulating motion which so puzzled the older students of this branch of anatomy.

On inspecting a zoosperm of this class, it is found to be divisible into a caput, which seems to correspond to the caput of the linear zoosperms, and appendages of various forms; the fact of these appendages being motionless appears to confer on them a

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EXPLANATION OF PLATES XI. AND XII.

PLATE XI.

FIG. 1.—Zoosperms of *Carcinus Mænas*, measuring 0·004^{mm} short diameter, 0·008^{mm} long diameter.

" 2.—Zoosperms of *S. Longirostris*.
- *a.* top view 0·007^{mm}.
- *b.* side view.
- *c.* younger zoosperms, 0·008^{mm}.

" 3.—Zoosperms of *P. Bernhardus*.
- *a* and *b.* side view; *a* is 0·004 broad, 0·006 long.
- *c.* side view slightly within focus.
- *d.* top view.
- *e.* " slightly within focus.

" 4.—Zoosperms of Lobster.
- *a.* side view, 0·004^{mm} broad, 0·012^{mm} long.
- *b.* top view, 0·007^{mm}.

" 5.—Spermatophorum of *S. Longirostris*.

" 6.— " *P. Bernhardus*.

" 7.— " *P. Misanthropicus*.
- *b.* more highly magnified. The head measures 0·15^{mm} across, 0·16^{mm} in length; stalk about 0·46^{mm}; pedestal 0·07^{mm}.

" 8.—Cells from testis of *P. Bernhardus*.
- *a.* cells examined immediately after death; larger measure 0·015^{mm}, smaller 0·013^{mm}. [FIG. 8.

significance differing from that of the tail or cilium of the moving zoosperms.

I will commence my description with the zoosperms of *Carcinus Mænas* (Fig. 1), these being the simplest form, consisting almost wholly of caput, a small, round, highly refractive particle, having the appearance of being solid and hard; on either extremity is a projection, the two being united by a ridge across the caput, as if the latter were carried on a rod which transfixed it; occasionally the projection of one side is wanting, in which case the zoosperm seems incomplete; the rod is very often curved instead of being straight; there is, in fact, a good deal of irregularity in their forms; they measure in diameter $0 \cdot 004^{mm}$; their length, including projections, which occupy half the extent, $0 \cdot 008^{mm}$. This form appears to correspond simply with the caput of other zoosperms; and as there is no cilium, so there is no motion.

The zoosperms of *Maia verrucosa* are slightly more complicated than the last, *viz.* a round disc, representing the spherical

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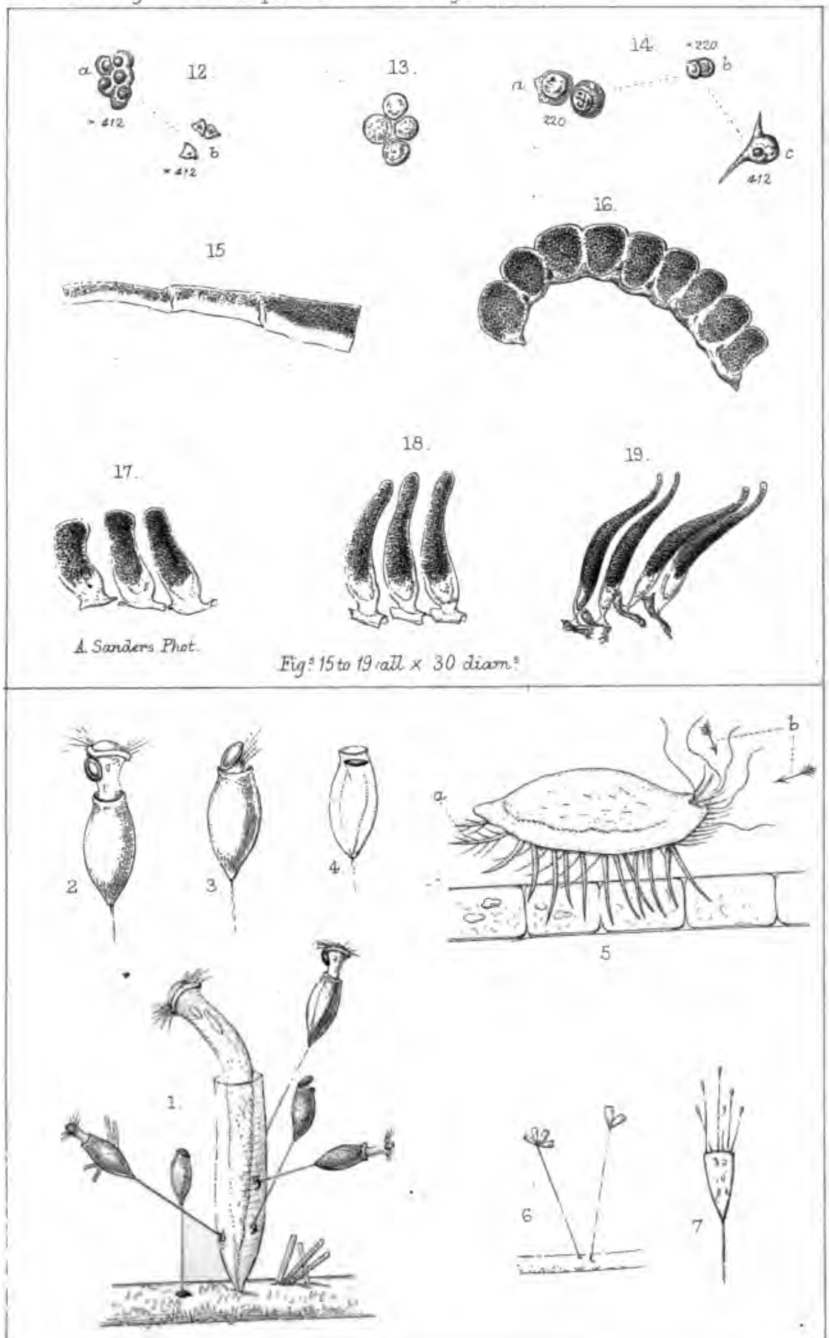
FIG. 8.—*b*. same after remaining some time soaking in the blood of the animal; largest nucleus measures $0 \cdot 010^{mm}$, smallest $0 \cdot 008^{mm}$.
c. smaller cells; largest $0 \cdot 010^{mm}$, smallest $0 \cdot 008^{mm}$.
d. cells with smooth nuclei.
e. „ rod-like nuclei.
f. „ double rod-like nuclei.
g. „ „ granular nuclei.
h. „ amœboid movements.
„ 9.—*a*. Cells from testis treated with water.
b. cells treated with liq. potassæ.
c. „ „ acid acet., granular nucleus.
d. „ „ „ „
e. „ „ „ „
„ 10.—*a*. Smaller cells from testis of *P. Bernhardus*, measuring 0·010 long and 0·007 broad.
b. cells with external nuclei. *α*. nucleus; *β*. cell.
c. „ *α*. with smooth nuclei and vacuoles; *β*. vacuoles have disappeared, leaving the centre of the cell empty.
„ 11.—Mature zoosperms to which water has been added.
a. commencing.
b. full effect.
α. caput; *β*. tail.

PLATE XII.

FIG. 12.—Transition stage between cells and zoosperms.
a. cells with refracting nuclei; length 0·008, nucleus 0·005.
b. triangular bodies resembling the caput of mature zoosperm; $0 \cdot 007^{mm}$ broad, $0 \cdot 006^{mm}$ long.
„ 13.—Cells from testis of *S. Longirostris;* largest measures 0·010 in. diameter.
„ 14.—*a*. Cells from testis of lobster; $0 \cdot 020^{mm}$; nucleus $0 \cdot 013^{mm}$.
b. cell with external nucleus; 0·016 long, 0·011 broad.
c. stellate body; the third ray is not visible in this specimen.
„ 15.—Commencement of spermatophorum of *P. Bernhardus;* three sections with dividing dislocations shown in figure.
„ 16.—Succeeding stage; small parcels of zoosperms are seen between some of the young spermatophora.
„ 17, 18, 19.—Subsequent stages of development of spermatophora.



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Crustacean Zoosperms — New Infusoria

part of that of *C. Mænas,* and a rod projecting from its centre; this rod, unlike the corresponding part in *C. Mænas,* projects only on one side; in this case the sphere of the latter is flattened out, and in the process becomes somewhat larger, measuring $0 \cdot 005^{mm}$ across; thus far the same elements exist in both; but *M. verrucosa* has in addition four or five fine lines projecting in a radiating manner from the circumference of the disc; in *Stenorhyncus Longirostris* (Fig. 2*a* and *b*) this species of zoosperm is exhibited in a slightly higher form. Here, also, the basis is a disc, thick and bevelled off on one side, on the other projects a rod, which rises in a series of steps to its summit, having for its base a broad pedestal, on which is a short piece of less diameter; on this, again, is another still smaller, the whole having the appearance of a telescope drawn out to its full length; the circumferential rays are usually five or six in number, although often one or more of them are wanting; they seem to be composed of a fine transparent matter, very thin and slender, so as to be almost invisible; they have apparently the same character as the vibratile cilium of monads, but instead of being flexible and mobile, they are stiff and motionless, or rather they recall to mind the rays of *Actinophrys Sol.* The disc measures across $0 \cdot 007^{mm}$; it has a slight tendency to deviate from the round to the pentagonal form; on looking at it from above, one sees a spot in the centre, this is the rod; round this is a circular line, which marks the edge of the pedestal, outside which is the surface of the disc; this is seen more plainly (Fig. 2*c*) in younger zoosperms.

Viewed on the side, the zoosperm presents a flat surface in front, bounded by a dark line, upon which is placed the pedestal of the rod, not always in the centre, and from the edges of which arise the rays, projecting upwards and forwards; behind this line is a broad band of transparent substance occupying the whole breadth of the disc; its hinder contour is slightly concave, but the contour of the disc, being convex, the small space left between the two is filled by a darker material; in another specimen the hinder contour of the disc was flat, the latter matter being absent.

In the Hermit Crabs (*P. Bernhardus*) an advance in complexity of structure is visible; the head is a conical body in shape, somewhat like a rifle-bullet; there are rays and a motionless tail, but no rod. To enter into detail, a zoosperm (Fig. 3*a*) placed on its side presents for examination a head either sharply conical or with one end rounded, approaching the spherical in form; from the base of this project, at a greater or less angle, three sharply-pointed rays; they are longer in proportion to size of the head than those of *S. Longirostris;* in most cases they are simply attached to the head, but in others their roots appear to penetrate into its interior to meet in the centre, their point of junction (Fig. 3*b*) being marked by a bright spot; this is analogous to the case of *C. Mænas,* where the

rod apparently runs across the zoosperm; the tail is attached to the space between the origins of the rays; it consists of a single stem, which soon divides into three or four branches; it is of a softer material than the rays, being more gelatinous in appearance, and having almost the same refracting power as the fluid in which it is examined. When the head is viewed slightly within focus on the side, a dark line is visible running from the centre towards the apex, a little on one side; the top view of the zoosperms shows their contour to be circular; in this position a dark spot is to be seen, not always central, surrounded by a bright line, which again is bounded by the dark line forming the circumference of the head; from this the three rays project equidistant. When on this view it is within focus, the centre spot is bright, instead of being dark. I am inclined to think that the rays correspond to the rod of zoosperm of *S. Longirostris*, their firmer character pointing to their affinity to this, rather than to the softer circumferential rays, which more resemble the tail of *P. Bernhardus* in the transparent, fine, and gelatinous nature of their appearance.

Professor Kölliker,* in his paper "On the Universal Formation of Zoosperms in Cells," gives a figure of the zoosperms of *P. Bernhardus*, in which the tail is represented as a long vesicular appendage forked at the end, and the whole zoosperm finally without rays, which are supposed to drop off in course of development. I have every reason to believe that this appearance is due to the addition of water.

(Fig. 4*a and b*). In the Lobster (*Homarus vulgaris*) the zoosperms have the same number of parts as in *P. Bernhardus;* the caput or head is here drawn out into a cylinder, which appears to have solid and firm walls, and to contain a substance of less consistence, but still solid; this substance leaves at one end a small cavity, projecting from which and filling up its mouth, is an irregular heap of granules, which seems to represent the tail of zoosperms in *P. Bernhardus;* between the walls of the cavity and the base of the heap of granules arise three rays, extremely long and flexible, ranging from $1\frac{1}{2}$ to $2\frac{1}{2}$ times the length of the cylinder; the transverse section of this body is circular, and the contents appear to be granular; the length of the cylinder is $0 \cdot 012^{mm}$, its breadth being $0 \cdot 004^{mm}$.

Leydig † thinks it probable that this kind of zoosperm undergoes a further development in the spermatheca of the female: on this question I cannot give a decided opinion, as I only examined one female specimen, a *S. Longirostris*, which had been some time in spirits of wine; the zoosperms in the spermatheca of this specimen certainly showed no signs of higher development, there being

* 'Nouveaux Mémoires, Société Helvétique.' Bd. 8. Fig. 37*c*. Taf. 3.
† 'Lehrbuch der Histologie,' S. 535.

no more alteration than could be accounted for by the action of the preservative.

Having fully described the zoosperms in four species of crustacea, we now come to the consideration of the vessels destined to convey them into the spermatheca of the female, *viz.* the spermatophora, these are precisely alike in *C. Mænas*, *M. verrucosa*, and *S. Longirostris*, so that the description of one will equally apply to the others; in all these species (Fig. 5) they consist of a spherical body, whose walls are formed of a fine and transparent membrane, not divisible into more than one layer, and consisting apparently of chitine; they occur of all sizes, ranging from that of the figure down to some only just large enough to contain three or four zoosperms; others are empty: the larger ones are generally full of zoosperms, so crowded together that the outlines of the latter are indistinguishable.

The lobster does not possess any proper spermatophorum; the zoosperms having arrived at the vas deferens are found imbedded in an extremely viscous and granular substance, which fills up the whole tube.

In *P. Bernhardus* (Fig. 6) the spermatophora consist of two distinct parts, a basal portion, flat and oblong, and the spermatophorum proper; the basal portion is formed of a material which it is difficult to tear asunder with needles, being of a tenacious and rather elastic nature; numerous granules are dispersed over the surface, the larger ones being collected near the edges; transversely across the middle line are sometimes seen large spaces or holes, indicating the former separation of the base into distinct sections; where the holes do not exist, their place is occupied by a faint line, the intervals between them are occupied by the spermatophora proper, which arise by root like processes from the central line of the bases, and project at right angles; their number varies from one to seven, they are of an elongated lanceolate shape, their structure is as follows: from the root-like processes arises a solid rod, which soon divides into two thick branches in a forked manner, these becoming thinner run up on each side to the apex where they join, thus forming the framework of the spermatophorum; the interval is occupied by a fine hyaline membrane, enclosing the cavity of the spermatophorum, which is densely filled with zoosperms, but leaving an empty space towards the root; there is almost always a small cavity in the wall, where the framework becomes thinner, containing a few zoosperms which seem to have become separated from the general mass; in one specimen that I examined, this collection occupied a projection in the form of a hook-like process of the wall. When the spermatophora are squeezed, the zoosperms are seen to emerge from the apex, where the framework is thicker but softer than the remainder; the opening closes again by the

elasticity of the walls; the transverse section generally gives an oval outline, but sometimes the shape is quadrangular, this depends on the existence of other fine rods than the two above mentioned.

In a small species of Pagurus, *P. misanthropicus* (Fig. 7), the spermatophora are of a different form and structure from the foregoing: in the first place they are separate from each other, the basal portion forming a small round disk, from the centre of which springs a long stalk, filled with a sort of medulla; on the upper extremity of this is placed the spermatophorum proper, nearly globular in shape. A higher magnifying power shows it to be surrounded by two membranes, but of this I could not be certain as I omitted to bisect it; however, the outer one appears to be a continuation of the sheath of the stalk, the inner one being connected with the medulla of the same; from the apex of the medulla appears also to arise a fine sort of connective tissue, binding the zoosperms into one mass. It only now remains to describe the development of the zoosperms; having paid more particular attention to that process in *P. Bernhardus*, I will give the details of it in that species.

The testes of *P. Bernhardus* consist of a glandular part and an excretory duct. The glandular portion of the right testis is situated between the liver and dorsal surface of abdomen, rather on the left side, the duct crossing to the right side of the thorax, towards its exit at the base of the fifth thoracic limb. The glandular portion of the left testis is placed deeper, between the two lobes of the liver, and resting on the abdominal muscular mass; it is altogether smaller than the corresponding portion of the right testis. The gland is tubular, having numerous enlargements, or sacculi, resembling the large intestines of mammals somewhat in form. Its lower end is filled with mature zoosperms, which decrease in number towards the distal extremity, where nothing but sperm-cells are to be found, which on their part had gradually increased in number. These vary much in size and shape. If immediately that the animal has been killed by chloroform a piece of the gland is transferred with the utmost dispatch on to a glass slide, on which a drop of the blood of the animal has previously been placed, and then the walls are separated by needles, the cells drop out without themselves being touched, the field of the microscope is found filled with these cells, floating about either singly or in groups. (Fig. 8*a*) At this period they are uniformly granular, and appear like semi-solid globules of matter, without the slightest appearance of either nucleus or cell-wall; neither is there anything whatever to lead one to suppose that they arise from mother-cells, there being no appearance of a cell-wall round any of the groups. (Fig. 8*b*) After they have remained some time in the fluid a sort of precipitation occurs in their interior, and a nucleus appears. This is also granular, and seems solid. Occasionally the nucleus is surrounded by a clear

space, as if the rest of the cell-contents had retreated towards the circumference by a sort of repulsion. It is quite possible that this space is filled with fluid squeezed out of the interstices between the granules by their closer approximation when forming the nucleus. These cells vary in size from $0 \cdot 013^{mm}$ to $0 \cdot 015^{mm}$, and the nucleus from $0 \cdot 008^{mm}$ to $0 \cdot 010^{mm}$. (Fig. 8*c*) Besides these larger cells, there are also smaller ones, granular like the former, appearing to be solid, often developing a granular nucleus, but sometimes not showing one, even after having remained some hours on the slide. They range in diameter from $0 \cdot 008^{mm}$ to $0 \cdot 010$, being of the same size as the nuclei of the larger cells. It was not evident that they had been set free by the breaking up of the latter; but rather they gave me the impression that they were a younger form becoming transformed into them by a process of continuous growth.

These are not the only form of cell to be found at this part of the testicular tube. There are others (Fig. 8*d*) whose nucleus is round and perfectly smooth. Some of them are as large as the first-mentioned cells: others are larger than the nuclei of the same. Thus they measure from $0 \cdot 011^{mm}$ to about $0 \cdot 015^{mm}$. It will be observed, on looking at the figure, that the nucleus varies in position, being nearly in the centre in one cell; in another just touching the margin; and in the two others even projecting beyond. (Fig. 8*e*) Occasionally there occur cells with an elongated rod-like nucleus. These resemble the last in every other respect but shape of the nucleus. Sometimes the latter occurs double (Fig. 8*f*), which seems to take place by the single one doubling over and separating in the middle.

Some of the cells (Fig. 8*g*) appear to be undergoing division. They have two granular nuclei, and are rather larger than the former, measuring $0 \cdot 021^{mm}$ in diameter.

In one case (Fig. 8*h*) amœboid movements of small extent, but very distinct, were seen, a protuberance appearing suddenly first, on one side and then on the other; the cell afterwards remaining stationary for some time. This is the only instance of these movements which occurred during my investigations. It was first noticed in sperm-cells by St. George de la Valette.* The nuclei in these are larger than in the former cells, occupying nearly the whole extent. I did not expressly look for this movement, or perhaps I should have met with it oftener.

These different kinds of cells vary greatly in number in different animals. In one specimen nearly all would have granular nuclei; in another, the smooth ones would greatly predominate; and again, in another, nearly all the cells would have rodlike nuclei. I have found the blood of the animal to be the best medium in which to examine these cells. It is true there are blood-corpuscles present in

* Max Schultze's 'Archiv,' Bd. 1, Heft 1.

that fluid, but then they are of a totally different nature from the sperm-cells; and moreover, when the blood coagulates, which it does very soon after it is drawn, all the corpuscles are involved in the coagulum, leaving the fluid part quite free. The slightest addition of water to the medium quite alters the appearance of the cells, and gives them all the appearance of having a cell-wall and vesicular nucleus (Fig. 9 *a*). If too much water is added, they burst, leaving behind only a mass of granules (Fig. 9 *b*). Liq. potassæ has a still more considerable effect in the same direction, swelling the cells out to a large size, and having the same action on the nucleus.

The addition of dilute acetic acid has just the contrary effect to that of water: it seems to coagulate the cell substance, it makes the nucleus more apparent; in some cases the nucleus (Fig. 9 *c*) is seen to be composed of an irregular mass of granules, coarser than those of the rest of the cell; in others the nucleus may be surrounded by a well-defined, but irregular dark line, which separates it sharply from the cell contents (Fig. 9 *d*). Again the nucleus may be a regular circle with a smaller one in the centre (Fig. 9 *e*), resembling a nucleolus; the effect of prolonged maceration in the acid is to dissolve the external part of the cell, leaving the nucleus portion floating free in the fluid.

We now come to a series of cells smaller than the last, but connected with them by a regular gradation in size; some look as if they were two cells (Fig. 10 *a*) joined together by an intermediate substance, the nucleus being outside the cell, and resembling it in appearance, so that it is difficult to distinguish one from the other; others have the external nucleus (Fig. 10 *b*) round or square; some, again, have a portion of the body of the cell occupied by a mass of vacuoles in addition to the nucleus, or may even have the vacuoles without the nucleus; the vacuoles continually break into each other, until a vacant space is left in the centre, surrounded by a thin layer of cell substance (Fig. 10 *c*).

In order to understand (Figs. 11 *a* and *b*) the significance of these cells, it will be necessary to consider the effect of water on the mature zoosperm: this re-agent, applied in small quantities, swells out the tail gradually until it becomes a round vesicle, the rays being first pushed upwards, then disappearing entirely, the head in the meanwhile taking a circular form, its edges being darker than those of the tail, as might be expected from its more solid character. If these figures are compared with Fig. 10, great resemblance in shape will be seen, the water seeming to make the mature zoosperms retrograde, as if the process of development had been the squeezing out of the superfluous moisture from the sperm cells, the subsequent addition of which to the mature form reverses the process, and restores in some degree the original shape.

There are two forms of cells which seem to supply connecting links between Fig. 10 and the fully-grown zoosperms (Fig. 12), these are cells whose nuclei are more consolidated and firmer than those of the cells which have as yet been under consideration; they refract the light considerably, and have a spot in the centre surrounded by a dark circle; the other forms are triangular and present all the appearance of the heads of zoosperms, than which they are rather larger, the spot in the centre of these is dark, the line round having become triangular.

The interpretation I am inclined to place on the above series of facts is that the zoosperms are derived from the cells with smooth nuclei, which gradually diminish in size, and at the same time increase in consistence, until they are transformed into mature zoosperms; the nucleus appears to form the head, the remainder of the cell becoming the tail and rays, so that no part of the zoosperm is formed within a cell membrane. On this view I confess that I do not see how the larger cells are concerned in the process; they are too large to be consolidated into zoosperms direct, for if that were the case, the smaller cells would be of a greater consistence and larger size than they are actually found to be. I think it more probable that they become transformed into the latter by cell division, an idea which is rendered more likely by the fact, that there is every gradation of size between one form of cell and the other.

According to Kölliker,* it is the nucleus which forms the tail, while the rest of the cell forms the head; but in a subsequent paper,† in which he abandons his former opinion concerning the development of zoosperms in favour of the doctrine that they arise entirely from the nucleus, he considers that all these motionless zoosperms are only altered nuclei. My researches do not countenance either view, the presence of both nucleus and cell substance disproving the latter, and the gradual consolidation of the nucleus making the former view untenable.

I have every reason to believe that the process of development is substantially the same in all the species examined; the sperm cells of *S. Longirostris* (Fig. 13) differ only from those of *P. Bernhardus*, in having fewer, but larger granules scattered through their substance; the amount of change required to transform them into mature zoosperms would be less than in the latter species.

In the lobster (Fig. 14) the sperm-cells have very large nuclei, whose appearance is more like a vesicle than in *P. Bernhardus;* their contents are very granular, there are present smaller cells, with the nucleoid body external, resembling the corresponding cells in *P. Bernhardus*, but exceeding them in size, as would be expected, from the larger size of the zoosperms in the lobster.

* Loc. cit. † 'Zeit. f. wiss. Zoologie,' Bd. 7.

There are also present stellate bodies, which appear to form the transition state between the cells and the mature zoosperms.

The development of the spermatophora of *P. Bernhardus* takes place in the epididymis and upper portion of the vas deferens, and is effected as follows:—The part which I have called the epididymis commences by a narrow orifice from the dilated extremity of the testicular tube: it consists of three concentric circles, of which the central one is the commencement; these are filled with a tenacious granular mass, containing, besides corpuscles, vacuoles, or oval spaces filled with a transparent mucous substance. The zoosperms collected in large numbers in the extremity of the testicular tube are forced through the narrow orifice in a continuous stream, by the peristaltic action of the walls of the tube, and are then immediately surrounded by the tenacious substance above mentioned, while the mucoid substance forms round them a ribbon-like tube, which is compressed and straight, the edges being thicker than the sides form the supporting rods of the future spermatophorum. This ribbon is divided into sections by a sort of dislocation, the two ends are then squeezed together, and the tenacious substance is applied to one side at first in a thin layer to each section; they have now arrived at the commencement of the vas deferens. As this tube becomes wider, the apices become longer, and soon assume the form of the mature spermatophora. At first they occur singly in a single row, and the bases do not coalesce until some distance down the vas deferens; this appears to be an instance of vital action or change going on in a formed material. The carmine solution does not colour the transparent envelope of the spermatophorum, yet this changes in shape apparently by its own inherent forces.

I have used the word "cell" in the foregoing description as the most convenient at present in use, organic unit is too long, "particle" or "corpuscle" is a source of endless confusion, "germinal matter," besides being too indefinite, would properly apply only to the nucleus; it must be understood that the word I have used has only the restricted sense, recently put upon it by Professor Max Schultze.* His definition of a cell is "a lump of protoplasma without an envelope, and containing a nucleus;" and he considers that both parts are derived from the corresponding part of a preceding cell. With regard to the word "protoplasma," I do not think it so good as "cell substance," inasmuch as it involves a theory, and would be inappropriate, if Professor Beale's doctrine of the primary formation of the "germinal substance" or nucleus should prove to be correct, whereas the term "cell substance" is equally applicable whichever view of the case should be adopted.

* 'Ueber Muskelkörperchen und das, was man eine zelle zu nennen habe.' 'Archiv,' f. Anat., 1861, pp. 9 and 11.

II.—*Protoplasm and Living Matter.* By Dr. LIONEL S. BEALE, F.R.S., Fellow of the Royal College of Physicians; Physician to King's College Hospital; and lately Professor of Physiology and of General and Morbid Anatomy in King's College, London.

(*Read before the* ROYAL MICROSCOPICAL SOCIETY, *April* 14, 1869.)

THE frequent use of scientific terms, the meaning of which is imperfectly understood, or inaccurately defined by the authors who employ them, is a fertile source of embarrassment to the student of science, as well as a serious hindrance to the free diffusion of correct scientific information. And it unfortunately happens that in some instances the evil is increased as knowledge advances; for the meaning of a word necessarily becomes modified as new facts are brought to light, and after a time the word represents something very different from the idea it was originally intended to express. Moreover, it sometimes happens that the same word is used by several different authors in different senses, and at last accuracy is only rendered possible by the introduction of entirely new terms, having a definite and restricted meaning.

The term "Protoplasm" may be adduced in illustration of the above remarks. This word is now applied to several different kinds of matter,—to substances differing from one another in the most essential particulars. It seems, therefore, very desirable that its meaning should be accurately defined by those who employ it, or that it should be superseded by other words. If certain authors who have investigated the subject were asked to define exactly the characters of the matter which they called protoplasm, we should have from those authors definitions applying to things essentially different from one another. Hard and soft, solid and liquid, coloured and colourless, opaque and transparent, granular and destitute of granules, structureless and having structure, moving and incapable of movement, active and passive, contractile and non-contractile, growing and incapable of growth, changing and incapable of change, animate and inanimate, alive and dead,—are some of the opposite qualities possessed by different kinds of matter which have nevertheless been called protoplasm.

In this communication I propose to refer very briefly to the conclusions which have been arrived at with reference to the nature of the so-called protoplasm, and I shall endeavour to trace the gradual changes and alterations which advancing knowledge and new theories have occasioned in the meaning of the term. I shall ask the Society to consider if it is not desirable that the meaning of this word, now in common use, should be more accurately defined than it has been hitherto. We may also venture to inquire if some

other term might not be more advantageously employed in speaking of certain of the substances which have been included under "protoplasm." Lastly, I shall endeavour to show that in all living beings there exists matter in two very different states—living and non-living; and that matter passes from one state into the other condition suddenly, not gradually,—that, in short, it is either living or not living, and that the living and the non-living cannot be regarded as the same substance, and ought not to be called by the same name. It seems obvious that if living matter is to be called protoplasm, the term should be restricted to this alone, and in no case made to include non-living matter, unless indeed it can be proved scientifically that there is no difference between living and dead, that our ordinary notions on the subject are quite erroneous, and that the words "living" and "dead" only serve to mark distinctions which are not real, but exist only in our imaginations.

A definition of protoplasm, most probably written by the late Professor Henfrey in 'Griffith and Henfrey's Micrographic Dictionary,' is as follows:—"*Protoplasm.*—The name applied by Mohl to the colourless or yellowish, smooth or granular viscid substance, of nitrogenous constitution, which constitutes the formative substance in the contents of vegetable cells, in the condition of gelatinous strata, reticulated threads and nuclear aggregations, &c. It is the same substance as that formerly termed by the Germans 'schleim,' which was usually translated in English works by 'mucus,' or 'mucilage.'" The surface of this mass constituted the "formative protoplasmic layer" which was supposed to take part in the formation of the cellulose wall of the vegetable cell. This was regarded by Von Mohl as a structure of special importance distinct from the cell contents, and it was named by him in 1844 the "primordial utricle."

In cases where protoplasm appears as a simple transparent homogeneous substance, several layers have been described, and it has been supposed that these different layers are concerned in diferent operations. This view has been extended to many forms of protoplasm, and the movements which occur have been attributed to the presence of two or more layers differing in density.

Clear, homogeneous protoplasm, it has been said, undergoes vacuolation, and becomes honeycombed, the spaces being filled with watery matter. In some instances, this change proceeds until mere protoplasmic threads are seen stretched across the cavity. The transparent fluid material occupying the spaces and the intervals between the threads is supposed to be the less important matter, and yet it is the living, growing, and moving substance; while the threads and walls of the spaces are composed of matter which has ceased to manifest these properties—matter which no longer lives, and which has been formed from the living matter. But we may fairly ask if

this lifeless, passive, formed matter, which cannot move or grow or multiply of itself, which is but a product of the death of protoplasm, is nevertheless to be called by the same name as the living, moving substance which it once was? If this be so, there ought to be no recognizable difference between matter which is actually alive and the substances which result from its death.

So far, then, we have seen that the term protoplasm has been applied to the matter within the primordial utricle of the vegetable cell, to that clear substance which undergoes vacuolation and fibrillation, and to the matter forming the walls of the vacuoles and the threads or fibrillæ. Still more recently, Von Mohl's primordial utricle has been called protoplasm by Professor Huxley, who some years before restricted the term to the matter within the primordial utricle, which matter at that time he regarded as an "accidental anatomical modification" of the endoplast, and of little importance.* The nucleus, and with it the protoplasm, Mr. Huxley thought, exerted no peculiar office, and possessed no metabolic power. Now, however, he considers "protoplasm" of the first importance; and under this term includes, I imagine, not only the primordial utricle and the "accidental anatomical modifications" it encloses, but the fully-formed cellulose wall of the vegetable cell. His "*endoplast*" and "*periplastic substance*" of 1853 together constitute his "protoplasm" of 1869.

Max. Schultze included under the head of protoplasm the active moving matter forming the sarcode of the Rhizopods as well as the substance circulating in the cells of Vallisneria, the hairs of the nettle, and other vegetable cells; and now it is generally admitted that the active, moving matter constituting the white blood-corpuscle, the mucus and pus corpuscle, and other contractile bodies widely distributed, is essentially of the same nature. The movements characteristic of this matter have been attributed to an inherent property of contractility; and this property has been held by some to be characteristic of, and peculiar to, protoplasm. Kühne considers all contractile material to be protoplasm, and includes the different forms of muscular tissue in the same category as the matter of the amœba, white blood-corpuscle, &c. But if we apply the term protoplasm to the contracting muscular tissue which exhibits *structure*, as well as to the living moving matter of the amœba, &c., in which no structure at all can be made out, it is obvious that these must be regarded as *essentially different kinds of protoplasm*, because they differ in properties which are essential and of the first importance. The contractile movement of the amœba, white blood-corpuscle, &c., is a phenomenon very different from the contraction of muscular tissue. In the first, movements occur in every direction, while the last is characterized by a repetition of movement in two definite

* "The Cell Theory," 'Med. Chir. Rev.,' October, 1863.

directions only. And when we come to study the matter which is the seat of these two kinds of movements respectively, we find very important differences. The matter of the amœba, white blood-corpuscle, &c., grows. *It takes up matter unlike itself, and communicates to it its own properties.* Now, muscular tissue does not do this. In short, the first kind of matter acts and moves of itself; but the last can only be acted upon and made to move. The first may be compared to a spring, as yet undiscovered, which not only winds itself up and uncoils, but every part of which moves in any direction, and can make new springs out of matter which has none of the properties of a spring; the last to a spring which can only uncoil itself after it has been wound up.

Further, the term protoplasm has not been applied only to the matter of which the amœba, the sarcode of the foraminifera, &c., is composed, and that which constitutes the white blood-corpuscle and such bodies, but the matter which is gradually assuming the form of tissue has been considered to be of the same nature. The radiating fibres of the caudate nerve-cells of the spinal cord have been termed protoplasm fibres, and the outer part of the nerve-cell with which they are continuous is composed of the same substance. The axis cylinder of the dark-bordered nerve-fibres and the fine ultimate nerve-fibres in peripheral parts have been looked upon as a form of protoplasm; but it is hardly necessary to remark that, whatever may be the nature of the material of which nerve-fibres and the outer part of nerve-cells are composed, it possesses properties very different to those manifested by the amœba, white blood-corpuscle, &c., and is destitute of the powers which characterize the matter constituting these bodies. Here again we find the term protoplasm applied to different kinds of matter or to matter in very different states.

But unfortunately we have by no means exhausted the confusion which has resulted with regard to protoplasm, for the name has been applied also to the outer, hard, dead part of epithelial cells and by implication to all corresponding structures.

Up to this time all observers have agreed in opinion that the cell or elementary part of the fully-formed organism consists of different kinds of matter, and it has been supposed that distinct offices were performed by some of these. They have been variously named. Cell-wall, cell-contents, nucleus, nucleolus, periplast, endoplast, primordial utricle, protoplasm, living matter and formed matter, are not all the terms that have been proposed. I think Prof. Huxley is the first observer* who has spoken of the cell in its entirety as a mass of protoplasm, and the only one who has ever asserted that any tissue in nature is composed throughout of matter which can properly be regarded as of one kind. This view appears

* "On the Physical Basis of Life," 'Fortnightly Review,' February 1, 1869.

to me incompatible with many facts, some of which have been alluded to by Mr. Huxley himself.* I doubt if in the whole range of modern science it would be possible to find an assertion which seems more at variance with facts familiar to physiologists than the statement that "beast and fowl, reptile and fish, mollusk, worm, and polype" are composed of "masses of protoplasm with a nucleus," unless it be that still more extraordinary assertion that what is ordinarily termed a cell or elementary part is a *mass of protoplasm;*—for can anything be more unlike the semi-fluid, active, moving matter of an amœba, than the hard, dry, passive, external part of a cuticular cell or of an elementary part of bone. I cannot forbear quoting in this place the following passage, which seems to me to require explanation. After stating that the substance of a colourless blood-corpuscle is an active mass of protoplasm, Mr. Huxley remarks that "*under sundry circumstances* the corpuscle dies and becomes distended into a round mass, in the midst of which is seen a smaller spherical body, which existed, but was more or less hidden in the living corpuscle, and is called its *nucleus.* Corpuscles of essentially similar structure are to be found in the skin, in the lining of the mouth, and scattered through the whole framework of the body." Now, what can be meant by a white blood-corpuscle dying and becoming distended into a round mass under sundry circumstances? Mr. Huxley goes on to say that at an early period of development the organism is "nothing but an aggregation of such corpuscles," that is, of corpuscles (elementary parts or cells) like those "found in the skin, in the lining of the mouth, and scattered through the whole framework of the body." This assertion is incorrect, inasmuch as the corpuscles in the embryo consist almost entirely of (living) matter like the white blood-corpuscle, while those of which the skin (cuticle) and most of the tissues of the adult are composed consist principally of formed matter with a very little of the other (living) matter, and in some cases the particles of cuticle are entirely composed of hard formed matter. Here, as in other cases, no distinction is drawn between that which is *living, growing,* and *forming,* and that which has *been formed* and is *destitute of all powers of life and growth.* No distinction between living matter and lifeless matter! Both are confused together under the term protoplasm, for which might be substituted "organic matter" or "albuminous matter." Huxley terms the particles of epithelium of the cuticle and of mucous membranes, masses of protoplasm. He says beasts and fowls, reptiles and fishes, are all composed of structural units of

* "The original endoplast of the embryo cell," Huxley says, in 1853, "has grown and divided into all the endoplasts of the adult," and "the original periplast has grown at a corresponding rate, and has formed one *continuous and connected envelope* from the very first."

the same character. Now, this mass of protoplasm, this unit, consists partly of *lifeless* and partly of *living* matter. The outer part, which may be dry and hard, and is lifeless, may be undergoing disintegration, and is perhaps being taken up by other living organisms, but is nevertheless, according to this view, just as much protoplasm as the living, growing, moving matter itself. No matter how many different things may be comprised in the cell or elementary part, no matter in what essentially different states these things may be, no matter how different parts may differ in properties—they constitute protoplasm. A muscle is protoplasm; nerve is protoplasm; bone, hair, and shell are protoplasm; a limb is protoplasm; the whole body is protoplasm. No anatomical investigation is necessary to enable us to detect this substance. Every beast, fowl, reptile, worm, or polyp that we see is protoplasm. Everything that lives or has lived is protoplasm.

Let me now draw your attention to a new form of protoplasm, which has been much discussed of late, and concerning the nature of which much difference of opinion is entertained. From the protoplasm of the amœba and certain forms of foraminifera, we pass to larger and more extended masses of this substance, included under the head of "urschleim," and constituting the organisms of the simplest animated beings, which have been included by Hæckel in the genus *Moner*. I refer to this part of my subject with diffidence, for I have not given much attention to it. It would, however, be wrong to omit all mention of what is at the same time very interesting and of great importance. I shall therefore quote the observations of others so far as they appear to me to bear upon the consideration of the nature of protoplasm.

In the 'Microscopical Journal' for October, 1868, is a memoir by Professor Huxley "On some Organisms living at great Depths in the North Atlantic Ocean," in which he states that the stickiness of the deep-sea mud is due to "innumerable lumps of a transparent gelatinous substance," each lump consisting of *granules, coccoliths,* and *foreign bodies,* imbedded in a "transparent, colourless, and structureless matrix." The granules form heaps which are sometimes the $\frac{1}{1000}$th of an inch or more in diameter. The "granule" is a rounded or oval disc, which is stained yellow by iodine, and is dissolved by acetic acid. "The granule heaps *and* the transparent gelatinous matter in which they are embedded represent masses of protoplasm." One of the masses of this deep-sea "urschleim" may be regarded as a new form of the simplest animated beings (*Moner*), and Huxley proposes to call it *Bathybius*. The "*Discolithi* and the *Cyatholithi*," some of which resemble the "granules," are said to bear the same relation to the protoplasm of *Bathybius* as the spicula of sponges do to the soft parts of those animals; but it must be borne in mind that the spicula of sponges are imbedded in a

matrix, which is formed by and contains, besides the spicula, small masses of living or germinal matter. As in other cases, this matrix, with the living matter included, constitutes the "protoplasm" of Mr. Huxley.

Dr. Wallich has, however, arrived at a very different conclusion. In a paper "On the Vital Functions of the Deep-sea Protozoa," published in No. I. of the 'Monthly Microscopical Journal,' January, 1869, this observer, who has long been engaged in this and kindred studies, states that the coccoliths and coccospheres stand in no direct relation to the protoplasm substance referred to by Huxley under the name of *Bathybius*. The former are derived from their parent coccospheres, which are independent structures altogether. "*Bathybius*," instead of being a widely-extending *living* protoplasm which grows at the expense of inorganic elements, is rather to be regarded as a complex mass of slime with many foreign bodies and the *débris* of living organisms which have passed away. Numerous living forms are, however, still found on it.

Dr. Wallich is of opinion that each coccosphere is just as much an independent structure as *Thalassicolla* or *Collosphæra*, and that, as in other cases, "nutrition is effected by a vital act," which enables the organism to extract from the surrounding medium the elements adapted for its nutrition. These are at length converted into its sarcode and shell material. In fact, in these lowest simplest forms, we find evidence of the working of an inherent vital power, and in them nutrition seems to be conducted upon the same principles as in the highest and most complex beings. In all cases the process involves, besides physical and chemical changes, purely *vital actions*, which cannot be imitated, and which cannot be explained by Physics and Chemistry.

Chemistry of Protoplasm.

From what has been said already, it must be obvious that the chemistry of the complex matter now termed protoplasm, embraces the chemistry of the formed matter, and the chemistry of the active, living, growing, matter, of the organism. By chemical analysis we can ascertain the composition of the first, and can learn many facts concerning its elementary chemical characters; but it is obvious that chemistry can teach us little with regard to the composition of the living matter, for we kill it when we attempt to analyze it; and in truth we analyze not the *living matter*, but the substances resulting from its death. Of course any one may say that the inanimate substances he obtains were the actual things of which the living matter was composed, but it is a mere assertion, for the bodies in question cannot be detected in the matter *while it is*

actually alive; and when obtained they do not possess the properties or powers characteristic of the living matter. What, therefore, can be gained by asserting that these things constitute living matter? What is the use of trying to make people believe and confess that there is no difference between a living thing and the same thing dead, when every one is perfectly satisfied that there is the very greatest difference?

And I must not omit to notice here a remark made by Mr. Herbert Spencer, which illustrates the extraordinary opinion entertained by him concerning the difference between living, growing, active, matter, and perfectly lifeless matter. "On the other hand, the microscope has traced down organisms to simpler and simpler forms, until, in the *Protogenes* of Professor Hæckel there has been reached a type *distinguishable from a fragment of albumen only by its finely granular character.*"* Mr. Herbert Spencer should prepare a solution of albumen and a solution of "protogenes," and by careful evaporation he might obtain two extracts not distinguishable from one another. Both would exhibit a "finely granular character," and thus the important fact that there was no difference whatever between the inanimate albumen and the inanimate "protogenes" would be demonstrated. And as everyone is already prepared to admit that there is no difference between dead "protogenes" and living "protogenes," we must of course accept the conclusion that the lowest forms of life are but forms of albumen. In this way "the chasm between the inorganic and the organic is being filled up," but it need scarcely be remarked, the operation is not likely to be completed for a short time.

Notwithstanding the clever and subtle arguments which have been advanced in its favour, and repeated over and over again in almost every possible form, the new doctrine of life has exerted very little influence. It is impossible to convince thoughtful persons that vital phenomena are physical and chemical phenomena, simply by asserting that they are so; and no matter how energetically the doctrine may be advocated, it will not be received unless it is proved to be founded upon facts. In spite of all that has been said, the chemist has taught us little concerning the nature of the changes which take place when pabulum becomes totally changed and converted into living matter, or when the latter gives rise to some peculiar kind of formed matter. He has shown us, it is true, that certain substances resulting in the organism during the disintegration of formed matter may be prepared artificially in the laboratory; but he knows as well as the physiologist, that their formation in the organism is conducted upon totally different principles, of the nature of which all are entirely ignorant. And it is childish to attempt, as some have done, to hide our ignorance by referring the actions

* 'The Principles of Psy ,' p. 137.

to cell-laboratories and molecular machinery, when every one knows there is nothing like a laboratory or machinery in any cell in any organism. And what is the use of talking about "subtle influences" (Huxley) effecting chemical change, without explaining what these subtle influences are?

Here are some specimens of the dogmatic assertions which have been advanced in place of facts and arguments, in favour of the physico-chemical doctrines. The difference between a crystal of calc spar and amorphous carbonate of lime corresponds to the difference between living matter and the matter which results from its death. Just as by chemical analysis we learn the composition of calc spar, so by chemical analysis we ascertain the composition of living matter. Can any one suppose that there is any real difference in the nature of the molecular forces which compel the carbonate of lime to assume and retain the crystalline form, and those which cause the albuminoid matter to move and grow, select and form and maintain its particles in a state of incessant motion? The crystallizing property is to crystallizable matter what the vital property is to albuminoid matter (protoplasm). The crystalline form corresponds to the organic form, and its internal structure to tissue structure. Crystalline force being a property of matter, vital force is but a property of matter. It might be objected that crystalline force keeps particles still and compels them to assume a constant form, while vital force prevents them from assuming any definite form at all and keeps them moving,—*form* being assumed only when the matter is withdrawn from the influence of the vital force; but these and any other objections raised to the physical theory of life are accounted absurd and frivolous. It has been asserted positively that there is but one true theory of life—the physical theory. Its advocates seem to think that any objections raised to this ought not to be listened to, because they consider it quite certain that by the rapid advance of molecular physics, the truth of their theory will by-and-by be fully established.

The properties possessed by inorganic compounds are supposed to be due in some way to the properties of the elements of which they consist. Thus it has been remarked that the properties of water result from the properties of its constituent gases, and are not due to "aquosity," as if any reasonable man would think of referring the properties of water to such a "subtle influence" as "aquosity." It has been argued that since the properties of water are due to its gases and not to *aquosity*, the properties of protoplasm are due to its elements, Oxygen, Hydrogen, Nitrogen, and Carbon, and not to *vitality*. But the cases are by no means parallel. Of water there is but one kind. Of protoplasm there are kinds innumerable. The constituent elements of the same particle of water may be separated and recombined again and again

as many times as we please; but the elements of protoplasm once separated from one another, can never be combined again to form any kind of protoplasm. But further, every kind of protoplasm differs from every other kind most remarkably in the results of its living, one producing man, another dog, a third butterfly, a fourth amœba, and so on. Now, what can be more absurd than to suggest that the properties of man, dog, butterfly, and amœba are due not to vitality, but to the constituent elements of their tissues? Are the properties of the elements of dog so different from those of the elements of man, as to account for the differences between dog and man? Wonderful properties have indeed to be discovered in connection with elements before we can refer the differences in property of living beings compounded of them to the properties of the elements. The argument advanced against vitality, as far as it rests upon the non-existence of aquosity, is utterly worthless, and it is astonishing that any writer who gave his readers credit for moderate intelligence should have adduced it at all.

The different forms and properties of living beings can only be explained by supposing the influence of force different from ordinary forces acting upon matter, or upon the existence of properties not due to the inorganic properties, but of a totally distinct kind, derived from pre-existing matter having similar, though perhaps not identical properties. These *vital properties* seem to be superadded to matter temporarily, and are obviously not permanent endowments. The one class of properties remains permanently attached to the elements of matter; the other may be once removed, but can never be restored. The material properties belong to the matter, whether living or dead; but where are the vital properties in the dead material? If physicists and chemists would restore to life that which is dead, we should all believe in the doctrine they teach. So long as they tell us their investigations only *tend* towards such a consummation, they must expect a few to be sceptical.

Mr. Huxley seems to maintain that protoplasm may be killed and dried, roasted and boiled, or otherwise altered, and yet remain protoplasm; but his "protoplasm" is after all only albuminoid or protein matter.* Huxley says lobster-protoplasm may be converted into human protoplasm, and the latter again turned unto living lobster. But the statement is incorrect; because, in the process of assimilation "protoplasm" is entirely disintegrated, and is not converted into the new tissue in the form of protoplasm at all; and he must permit me to remark that sheep cannot be transubstantiated into man, even by "subtle influences," nor can dead protoplasm be con-

* Mr. Huxley says "all protoplasm is proteinaceous; or, as the white or albumen of an egg is one of the commonest examples of a nearly pure protein matter, we may say that all *living matter* is more or less albuminoid." If the white of an egg is living matter, why should not its shell be so considered?

verted into living protoplasm, or a dead sheep into a living man. It is remarkable that Huxley himself, some sixteen years ago, drew a distinction between living and non-living matter which he now utterly ignores. He remarked that the stone, the gas, the crystal, had an *inertia*, and tended to remain as they were unless some external influence affected them; but that living things were characterized by the very opposite tendencies. He referred also to "the faculty of pursuing their own course" and the "inherent law of change in living beings." In 1853, the same authority actually found fault with those who attempted to reduce life to "mere attractions and repulsions," and who considered physiology "simply as a complex branch of mere physics." He also went so far as to remark that "vitality is a property inherent in certain kinds of matter."

To sum up in few words. The term protoplasm has been applied to the viscid nitrogenous substance within the primordial utricle of the vegetable cell and to the threads and filaments formed in this matter; to the primordial utricle itself; to this and the substances which it encloses; and to all these things, together with the cellulose wall; to the matter composing the sarcode of the foraminifera; to that which constitutes the amœba, white blood-corpuscle, and other naked masses of germinal matter; to the matter between the so-called nucleus and muscular tissue, and to the contractile matter itself; to everything which exhibits contractility; to nerve-fibres, and to other structures possessing remarkable endowments; to the soft matter within an elementary part, as a cell of epithelium; to the hard external part of such a cell; to the entire epithelial cell.

Inanimate albuminous matter has been regarded as protoplasm. Living things have been spoken of as masses of protoplasm; the same things dead have been said to be protoplasm. If the matter be boiled or roasted, it is still protoplasm; and there seems no reason why it should not be dissolved, and yet retain its name protoplasm.

Living Matter.

In conclusion, I venture to allude very briefly to my own views concerning the living matter of living beings.

When describing the results of my investigations upon the changes taking place during the development of the cells or elementary parts of the different tissues, in 1860, I should gladly have made use of the term protoplasm; but I found that at that time it had been applied to matter existing in two very different states—*living* and *formed*. As my investigations proceeded, I became more and more convinced of this remarkable distinction, and my account would have been quite unintelligible if I had not employed a different word in speaking of matter in each state.

The *living matter* is alone concerned in nutrition, growth, development, and the production of those materials which ultimately take the form of tissue, secretion, deposit, as the case may be. It alone possesses the power of growth and of producing matter like itself out of materials differing from it entirely in properties and powers. I therefore called it *germinal* or *living matter*, to distinguish it from the *formed material*, which is in all cases destitute of the properties possessed by the former. The difference between germinal or living matter and the pabulum which nourishes it, on the one hand, and the formed material which is produced by it, on the other, is, I believe, absolute. The pabulum does not shade by imperceptible gradations into the living matter, and this latter into the formed material; but the transition from one state into the other is sudden and abrupt. The ultimate particles of matter pass from the lifeless into the living state, and from the latter into the dead state, suddenly. Matter cannot be said to half-live or half-die. It is either dead or living, animate or inanimate; and formed matter has ceased to live. Matter may be more or less perfectly or imperfectly formed, and formed matter may differ in hardness, colour, consistence, and a number of other qualities, and it may gradually pass from one state into the other; but nothing of this kind is observed in the case of the germinal matter.

Now, since many kinds of formed matter have been called protoplasm as well as many kinds of the matter which is in the living state, it is obvious the word could not be used at all. From the time when my researches were made to the present, the confusion in the use of the word protoplasm has gradually increased, until every form of tissue has been thus called, as well as every kind of germinal or living matter. And it would only add to the existing confusion if an attempt were now made again to alter the meaning of the word; so that, upon the whole, it seems better to use the more simple term *living matter* to denote the growing, active, moving substance which is peculiar to everything living, and which is alone concerned in the multiplication, growth, and formation of all tissues and organisms. *Living or germinal matter*, *formed matter*, and *pabulum*, are the only terms required in describing the development, formation, and growth of tissue, the production of secretions, and other phenomena peculiar to living things; and I have ventured to suggest the use of these terms, because they have the advantage of being simple. They can be accurately defined and distinguished from other terms. They are short, expressive, and can be remembered without difficulty, and there is an absence of that mysteriousness which hangs about so many of our scientific terms in ordinary use, and greatly adds to the difficulties experienced by the student.

III.—*On some New Infusoria from the Victoria Docks.* By Wm. S. Kent, F.R.M.S.

(*Read before the* Royal Microscopical Society, *April* 14, 1869.)

Among the variety of forms of Infusorial life inhabiting the brackish waters of the Victoria Docks, two or three have come under my notice which seem to differ considerably from any species hitherto described.

My attention was directed to the species I shall first refer to, by Mr. Walter Reeves, Fellow of the Society, and to whom is due the credit of first discovering it. It belongs to the genus *Cothurnia*, but is readily distinguished from all other species belonging to that genus, by its possessing a well-developed operculum. This operculum is attached to the body of the animal immediately beneath the peristome, and being somewhat smaller than the aperture of the lorica, or investing-sheath, is drawn down into it on the animal retracting. A slight flexure of the disc now results, and the operculum then entirely conceals beneath it all the softer parts of the body, which are thus efficiently protected from fear of intrusion from without.

A like result, but through entirely different means, is arrived at in *Vaginicola valvata* of Wright, in which species a valvular trap-door-like apparatus is developed from, and attached by a hinge-joint to, the interior of the lorica, or investing-sheath; but this, from its mode and position of attachment, never makes its appearance on the outside of it.

The average length of the lorica in the species here introduced is 1–400″, and this, in common with the operculum and the proximal attachment of the pedicle, is composed of a substance resembling chitine, which, in the adult condition, is of a dark chestnut hue, the pedicle alone remaining perfectly transparent. At an earlier stage of growth the chitinous matter is of a pale amber

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EXPLANATION OF PLATE XII.

Fig. 1.—*Cothurnia operculigera.*—Specimens attached by their pedicles to the lorica of a larger species of the same genus, × 130.

" 2, 3, 4.—Individuals of the same species still further enlarged, showing the position of the operculum when the animal is fully expanded, and in different stages of retraction.

" 5.—*Euplotes paradoxa.*—At *a* are represented the ramose setæ, while the arrows at *b* indicate the direction of the current produced by the vibration of the flagelliform cilia placed in the vicinity of the oral region, × 250.

" 6.—*Acineta socialis*, × 160.

" 7.—A single individual of the same, × 660.

colour, readily permitting the contour of the contained animal to be defined through it, which is not possible after the darker adult hue has been assumed. As might be anticipated, however, every gradation of shade may be met with between the two extremes.

Throughout February, and so far through March, this infusorium has been taken in considerable abundance in both the Victoria and the Commercial Docks, attached either to *Cordylophora*, various minute algæ, or other organic substances. In more than one instance, I have observed small colonies which have selected the lorica of a larger species as their fulcrum for support, and from one of these, the accompanying illustration (Plate XII., Fig. 1) was taken.

Hitherto, I have not met with, nor heard of a single instance in which two individuals have been found occupying the same lorica, and hence it may fairly be deduced, that propagation by longitudinal fission, in this species, rarely, if ever, takes place.

While retaining the generic name of *Cothurnia*, I propose, in consequence of the peculiar apparatus above described, to distinguish this form from other species by the specific name of *operculigera*, and its characteristics may be technically expressed as follows:—

Lorica of a deep chestnut colour, somewhat gibbous, average length 1–400″. Body hyaline, bearing beneath the peristome a circular, chitinous operculum, of the same hue and consistence as the lorica. Pedicle transparent, varying from the same to twice the length of the lorica. Inhabiting brackish water.

Many microscopists would probably consider the characters afforded by this species of sufficient import to justify its being placed in a distinct genus; but in that case, it would be equally desirable that *Vaginicola valvata* should undergo the same treatment; and generic discrimination might certainly be based with far greater justice on the valvular apparatus of that species, and the opercular appendage appertaining to the one here treated on, than on the presence or absence of a supporting pedicle, which is given as the only diagnostic point of distinction between the two genera, *Cothurnia* and *Vaginicola*, as they at present exist. Neither can this distinction be accepted as a sound one, for though the long-stalked representatives of the first genus are distinct enough from the sessile *Vaginicolæ*, yet every gradation may be met with between the two, until in specimens resembling the one to which my new species is attached in the illustration, it is by no means easy to decide in which genus they should be placed; the very faintest apology for a pedicle possibly exists, but even this, it might be suggested, might in the third or fourth generation be entirely dispensed with; and more especially if called upon, as in the illustration, to act the part of foster-parent, by supporting the successive

progeny of the minuter and precociously affectionate offshoots from the primitive family stock.

Another animalcule, presenting certain peculiarities of structure which I would call attention to, belongs to Ehrenberg's genus *Euplotes*, altered to *Plæsconia* by Dujardin, but reinstated by Stein, and other modern writers. The *comprehensive* characters of this genus are, that the body is oval, more or less flattened, and enclosed by an apparent lorica; having the locomotive organs highly developed in the form of cilia, styles, and uncini.

The first point that arrested my attention on observing the animal figured (Plate XII., Fig. 5), was the ramose structure of the two posterior styles placed symmetrically on either side of the median line. Dujardin and Pritchard, however, state that this complex structure of the setæ is not of uncommon occurrence in this genus, and that the peculiarity has been more particularly observed in the species figured by the former writer, in his 'Histoire Naturelle des Infusoires,' Plate VIII., Figs. 1–4, 1841, as *Plæsconaria patella*, and as *Euplotes patella* in the 'Micrographic Dictionary,' Plate XXIV., Figs. 5*a*, 5*b*, 1860. In the latter work, however, (Fig. 5*b*) which, by the way, would furnish a good model for a *sensible* young lady's hat (chignons abandoned), no reference whatever is made to the ramose character of the setæ in either the text or plate.

My species appears to approach the above-mentioned one pretty closely, but, as before stated, two only of the styles are branched, while in *E. patella* the number is in excess; in that species, moreover, the general contour of the body seems to be more elongated and depressed, and the locomotive styles are not so long in proportion to the body, as may be observed by comparison with the accompanying figure. One great peculiarity characterizing my species, however, which, whether present in the other representatives of the genus or not, it is desirable to ascertain, lies in the fact of its possessing several very long and slender flagelliform cilia placed anteriorly in the vicinity of the oral region, and these being in a constant state of vibration, assist, with other shorter cilia, to produce a strong current in the direction depicted by the arrows in the illustration (Plate XII., Fig. 5*b*).

Unfortunately, I had only time to make a sketch of the little fellow in profile; yet, considering how famous the whole genus is for restless and erratic habits, I accounted myself rather fortunate in even securing that. It is also a matter of regret that no other specimen has since been met with; nevertheless, limited as these observations were, they suffice to show that this species is clearly very distinct from *Euplotes patella*, and still more so from the other described species of the genus, and characterizing it as below, I propose to distinguish it, on account of the remarkable develop-

ment of the ciliary appendages not hitherto observed in other allied species, by the name of *Euplotes paradoxa*.

Lorica oval, no striæ on the back, locomotive styles long and stout; furnished posteriorly with two ramose setæ, one on either side of the median line, between these and the locomotive styles several stout recurved uncini. Long filiform vibratile cilia present in the oral region. Length 1–200″. Inhabiting brackish water.

The next species I have to refer to, I assign, with some degree of hesitation, to the genus *Acineta*. The form is an excessively minute one, the body proper not exceeding 1–2000″ in length, and hence the larger representation (Plate XII., Fig. 7) depicts it magnified no less than 660 diameters linear, and is the appearance presented when viewed with a $\frac{1}{12}$-in. objective. Under a lower power it closely resembled a minute *Epistylis*, and might have been referred to the *E. botrytis* of Ehrenberg, had it not been for the presence of retractile tentacula, a character demonstrating its affinity to the *Acinetæ;* the distal extremity of these tentacula seemed swollen, but not permanently so, being apparently of a purely sarcodic nature, and altering in configuration at the will of the animal, and in this respect, closely approximating the pseudopodia of a Rhizopod. Hence my scruples for placing it in the genus *Acineta*, wherein it is now a well-established fact that the tentacular organs, with their distal dilatations, are nothing less than retractile tubes terminating in veritable suckers, wherewith these voracious animalculæ seize and retain their prey, and, by a mode of suction, transfer to their own bodies the nutrient matter contained in those of their victims.

Should the minute form here introduced eventually prove to be a true *Acineta*, it will differ from other described species, from the fact alone of its being placed in clusters on a common pedicle, the number of individuals in each cluster varying from two to five or six, and, in consideration of this circumstance, I propose, provisionally, to distinguish it by the name of *Acineta socialis*. Appended are its characters as so far determined.

Individuals, as in *Epistylis*, fixed on a long and slender pedicle; provided with retractile non-vibratile tentacula, as in *Acineta*, but these organs differing from those of the last-named genus, in being apparently of a simple sarcode material, instead of tubular structures provided with suckers. Length of individuals 1–2000″. Inhabiting brackish water.

In addition to the species just described, this rich hunting-ground, "the Victoria Docks," furnishes the microscopist with a variety of forms hardly to be met with in any other locality, and, in fact, may be described as a kind of neutral territory frequented by representatives of both marine and fresh-water genera. Ascending above the Infusoria, we find there one species, at least, of

the Nudibranchiate Mollusca, *Embletonia Grayii*,* *Mysis vulgaris*, *Plumatella repens* and also one of the Ctenostomatous Polyzoa, *Cordylophora lacustris*, *Spongilla lacustris*, and a numerous assemblage of Entomostraca and Rotifera, *Floscularia ornata* in great abundance included among the latter. Many of the above-mentioned forms are most frequently met with in our ponds and inland streams, while others betray a preference for salt water, and under these circumstances it seems highly desirable that a greater amount of attention than has hitherto been paid, should be brought to bear on the study of the fauna, both microscopic and otherwise, of the brackish waters around our coasts.

* A new species, exhibited and described by myself at the last February meeting of the Zoological Society.

IV.—*Professor Owen on Article VI., No. III., of the 'Monthly Microscopical Journal.'*

In reference to the remarks (p. 178, *op. cit.*) by Professor Beale (of whose labours in the advancement of our common science I gladly here avail myself to express my deep and grateful sense), permit me to observe that there are organisms (*Vibrio*, *Rotifer*, *Macrobiotus*, &c.) which we can devitalize and revitalize—devive and revive—many times. As the dried animalcule manifests no phenomenon suggesting any idea contributing to form the complex one of "life" in my mind, I regard it to be as completely lifeless as is the drowned man whose breath and heat have gone, and whose blood has ceased to circulate. In neither dead body, however, is there rest: the constituent force-centres (P. B.'s "material atoms") are at work: a stagnant force-centre is to my mind inconceivable—a contradiction in terms. The change of work consequent on drying or drowning forthwith begins to alter relations or "composition," and, in time, to a degree adverse to resumption of the vital form of force, a longer period being needed for this effect in the Rotifer, a shorter one in the Man, still shorter, it may be, in the Amœba.

Before continuing the analogical argument, I stop to note an objection which may be anticipated from P. B. The dried animalcule and drowned mammal, not too far decomposed to respond to the means of stimulating resumption of vital actions, he may say, are not dead: their "soul" or "life"—*animus* or *anima*, the "vital spark, principle, 'breath of life,' &c., has not departed from them." "The power of revitalizing is possible only so long as such abstraction lies latent in the sum of force-centres termed 'body.'" "When a drowned man is revived, his soul had not left the body," &c. For a little while such objection will pass and serve a purpose.

To resume. My remark, that "steel resists much longer the surrounding decomposing agencies," P. B. characterizes by a term imputing a certain weakness of mind in the remarker, such as might call up a smile of compassion or contempt, according to the idiosyncrasy of the imputer. What concerns the present question is that P. B. virtually, and I believe unawares, denies the truth of the remark. For example, when P. B. affirms that "you can magnetize and unmagnetize steel as many times as you like" (p. 179), I would not stigmatize it as "a naïve remark," but, in view of our common aim, I affirm it to be untrue. If steel resisted the surrounding decomposing agencies for ever, and not merely "for a much longer time," it might be magnetized and unmagnetized as many times as is conceivable, or as P. B. "would like." The contrary is evinced, by the fact that our planet exhibits

naturally no magnetizable iron, save such as has comparatively recently fallen from outward space. The savage tips his weapon with this meteoric iron: the more advanced man, dealing with the "ore," drives out the oxygen, the affinity of which for the metal has rendered all iron coeval with the earth defunct as regards the power of being magnetized. Other affinities affect "sarcode" in a much shorter time, and sooner render the jelly-speck defunct. But the difference is one of degree,—is not absolute as respects the time in which revitalizing or remagnetizing be possible.

Knowledge is limited and suggestive of opinion and belief as to the vast unknown; for guidance toward which opinion analogy alone, for a time, can be offered. To treat analogy as if identity had been predicated (*e.g.* "if the magnet moved itself"—"if it divided and multiplied"—"if every part of it were capable of moving"—"if it were able to select," &c. &c., p. 179), is more likely to mislead than to guide. I presume P. B. to hold an opinion or belief as to the vitalization of the primary granule or jelly-speck opposed to "nomogeny," or my conception of the powers assigned to the waters that, of old, abundantly brought forth the living and moving entities. The analogies supporting the alternative belief—thaumatogeny—would be more instructive than banter: but the party against which that weapon is used may take encouragement from the 'History of Controversy,' that it is groping in the right direction.

V.—*On the Construction of Object-glasses for the Microscope.*

By F. H. Wenham.

(*Continued from page* 228, *No. IV.*)

For the brass setting of object-glasses, it is necessary that the worker should possess a good foot-lathe; if provided with a self-acting arrangement for chasing up the short screwed parts of the cells, this will ensure greater accuracy of workmanship. The setting or metal work of an object-glass must always be made before the lenses are commenced; three steel gauges are to be first formed, of a width exactly corresponding to the diameter of the intended lenses; this gauge I make out of a piece of sheet steel, with three arms of the three diameters required. A chuck should be fitted to the lathe, and cut out to the standard thread now generally adopted for object-glasses; into this the brass setting is fitted, and each cell screwed on, and turned out in succession to the proper size. I leave no shoulders at the back of the cells, but bore them clear through.

Triblet tubing is not sufficiently accurate for the outer shell of the highest powers; it is better, therefore, to make this of one casting, and bore it out of the solid, from its own chuck, and finish to the size with a fluted rimer. I have always made the inner tube, containing the back lenses, to traverse to and fro, in preference to the front lens, as the object is not thereby lost sight of during the adjustment, which is performed in one-third of a revolution of the outer ring, which has an inclined groove cut in it, acting on a screwed pin connected with the inner tube. This plan is more simple in construction, and less liable to derangement than the one commonly employed.

On Reducing and Dividing Masses of Glass for Optical Purposes.

For this, the lapidary slicer and diamond dust are generally employed. Discs of glass are split into slices by the working lapidaries at such a trifling cost, that it is scarcely worth while for the amateur to attempt it. Should, however, a small and rare sample be immediately required for experiment, it may be readily sliced with a circular disc of soft iron, running in the foot-lathe, and fed with flour emery, and water; the edge of the slicer must be frequently notched with the sharp angle of an old file. The sample of glass or mineral is cemented to the end of a staff, and held preferably in the slide-rest. If the screw of the rest is taken out and the slide made slack, the work can be thrust up to the slicer with the pressure of the fingers, and there is less risk of fracture from undue violence. The sliced glass is cut into squares, a little exceeding the diameter of the intended lenses, by means of a glazier's diamond, and the corners rounded off with a pair of optician's "shanks" or nibblers, which are a species of pliers, made, in preference, of soft iron, as this grips the glass without slipping, as hard steel would do. This instrument, of a larger size, is capable of removing slivers of glass from the edges of a plate upwards of one inch in thickness.

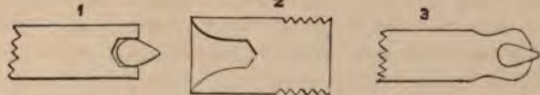
All glass is much softer than hardened steel; but if this is set to cut in a dry state, the heat generated at the working or abrading point softens the cutting edge, and speedily destroys its action; but if some turpentine is applied, this quite prevents the softening of the tool. In the lathe, or with a common Archimedian drill, holes may be drilled through thick plate-glass with surprising rapidity, if kept well bathed in turpentine. Masses of glass may also be turned in the lathe with a steel tool, if plentifully supplied with turps, and run at a moderate speed.

The first experimental parabolic condensers were made from plate-glass 1½-inch thick; pieces of this, nibbled rudely to form, were cemented on to a chuck. The T-rest was next placed nearly

on a level with the top of the work, and an old triangular saw-file, kept sharp *on one side only* by repeated applications to the grindstone, was then held on the rest, so as to attack the revolving glass slantways, or spokeshave fashion, with plenty of turpentine. By these means the glass was quickly reduced to form, so as to fit the template; and the ridges left by the file were swept away by means of small leaden laps, fed with emery and water of decreasing fineness. The polish was obtained by a rubber of willow-wood, cut crossways of the grain, used with crocus and water, and at last a lump of beeswax with very fine crocus was employed for the final polish.

For working small concave lenses as nearly as possible to their final form, a great deal of accurate and skilful turning is required. For this delicate work steel tools are quite unsuited, and diamond points are invariably used. The common practice of mounting these has been to solder them with brass and borax, by means of the blowpipe, into the end of a steel tube about the size of a watch-key, leaving a hole behind to prevent the diamond from being blown out during the fusion; but I have never found this method secure for small splinters. The brass has really no affinity for the diamond, but rather tends to avoid it; and this is frequently only held in by the glaze or flux. The loss of several diamonds induced me to abandon this practice, and since adopting the following mode I have never lost one. I take a piece of copper wire about $\frac{1}{12}$th of an inch thick, and drill a shallow hole in the end, of the size and depth required to contain the diamond, thus, Fig. 1;

1 2 3



a piece of steel is turned out with a bell-mouth, and hardened, as shown by Fig. 2. This is spun rapidly in the lathe, a drop of oil is applied, and the end of the copper rod containing the diamond is pressed hard in, at the same time giving it a slight rolling motion. Speedily the copper is compressed tightly round the diamond, as in Fig. 3, which becomes very firmly imbedded in the soft metal; and if the operation is carried too far, the copper rises over the point and completely buries the splinter.

By mutual abrasion, diamonds rapidly grind each other away, and two mounted in wires in this way may be kept mutually to a sharp point, by chucking one in the lathe and using another as a turning-tool. In employing these diamonds for turning glass, no particular directions are needed; they seem to cut rather better if the work is kept slightly moist.

The most convenient way for the amateur of reducing the substance, or giving the rough rounded form to small lenses, is a large plate of zinc and coarse emery and water; iron is too hard, lead too soft, and copper poisonous.

Of the Powders employed for Grinding and Polishing Glass.

For lenses, emery is almost invariably employed for rough grinding and smoothing. For the latter operation, it must be washed to various degrees of fineness, as it is seldom sold in this state, the sizes in commerce are merely sifted. Emery differs much in hardness and quality, according to the locality from which the ore is obtained. If it is full of small reddish particles of a dull slaty appearance, it is soft and deficient in the grinding property. The Guernsey emery is of this character and very inferior to the Naxos, the particles of which have a steely appearance of uniform colour; but this latter is difficult to obtain, as it is monopolized by some of the large plate-glass manufacturers. Three or four sizes are sufficient for the glass-worker for roughing down and fine grinding; but for smoothing, washed emery of several degrees of fineness are required. A portion of the flour of emery of commerce is placed in a bowl, or a common washhand basin, and well stirred up. At the end of ten seconds the water is poured into another bowl; this is repeated several times, till no more can be withheld from the original quantity. This washed quantity is again separated into several other degrees of fineness, as at the end of one minute, five, twenty, and sixty minutes; but after one hour, a very small quantity is obtained from one pound of the flour of commerce. This being of value for the perfection of the final smoothing, or obtaining a semi-polish on the metal lap or mould itself, I have preferred procuring it from the "optician's mud," or refuse of the previous grinding operations. Taken in an unprepared state, this contains a large percentage of impurities, consisting of ground-glass and metal particles from the laps; it is therefore necessary to remove them. The first by boiling the mud with caustic potash, and after washing away all trace of the alkali, finally treating with dilute sulphuric acid. The finest portion only of one hour's suspension may then be separated and obtained in a satisfactory quantity.

The polishing powders used by the workers of minute lenses, are putty-powder, or oxide of tin, and crocus, or peroxide of iron. The first may be obtained sufficiently good without any difficulty; but after many trials both by roasting the alkaline precipitate from sulphate of iron, and also carefully washing the crocus of commerce, I have given the preference to jewellers' rouge, sold by Acton, of Farringdon Street. In this form it is far too soft for glass polish-

ing; it must therefore be heated in an iron pot, and diligently stirred till the mass acquires a purple colour; it is then of the requisite degree of hardness. Both this and the putty-powder must be washed to separate gritty particles; about five minutes will be sufficient. After obtaining all that can be suspended in this time, the residue may be levigated on an iron plate with a soft iron spatula, and the washing continued at pleasure; but the result of all the washings is sure to contain some gritty particles, which must be separated by repeated washings, till nothing whatever will settle at the end of five minutes. Two sizes of crocus only are needed; the last is obtained from the washed mass after one hour's suspension, and is very small in quantity, but of much value for obtaining the finest polish on prism work, either in glass or calc spar. The ordinary washed crocus, used alone, I have found too keen, and apt to cling to and raise streaks on the polishing laps; I therefore always mix it with an equal part of the putty-powder, which quite remedies the evil; an uniform mixture is best obtained by stirring them together with water.

(*To be continued.*)

VI.—*Description of Parkeria and Loftusia, two Gigantic Types of Arenaceous Foraminifera.* By Dr. Carpenter, V.P.R.S., and H. B. Brady, F.L.S.*

The authors of this memoir commence by referring to the separation of the series of *Arenaceous* Foraminifera from the *Imperforate* or *Porcellanous*, and from the *Tubular* or *Vitreous*, first distinctly propounded in Dr. Carpenter's 'Introduction to the Study of the Foraminifera' (1862), on the basis of the special researches of Messrs. Parker and Rupert Jones; who had pointed out that, whilst there are several genera in some forms of which a cementation of sand-grains into the substance of the calcareous shell is a common occurrence, there are certain genera in which a "test" formed entirely of an aggregation of sand-grains takes the place of a calcareous shell; and that these genera constitute a distinct family, to which important additions might probably be made by further research.

The propriety of this separation of the *Arenacea* from the calcareous-shelled Foraminifera has been fully recognized by Professor Reuss, the highest continental authority upon the group; who had come to accept the principle laid down in Dr. Carpenter's successive Memoirs,† that the *texture of the shell* is a character of

* Dr. Sharpey has kindly permitted us to reproduce the following abstract of this most important paper.

† 'Phil. Trans.,' 1856-60.

fundamental importance in the classification of this group, the *plan of growth* (taken by M. d'Orbigny as his primary character) being of very subordinate value; and who had, on this basis, independently worked out a systematic arrangement of the entire group, which presents a most remarkable correspondence with that propounded by Dr. Carpenter and his coadjutors. And their anticipation of important additions to the Arenaceous series has been fully borne out, on the one hand by the discovery of several most remarkable new forms at present existing at great depths in the ocean, which has been made by the dredgings of M. Sars, jun., and those of the 'Lightning' Expedition; and, on the other, by the determination of the real characters of two fossils, one of the Cretaceous, and the other probably of the earlier Tertiary period, which prove to be gigantic examples of the same type.

The first of these, discovered by Professor Morris more than twenty years ago in the Upper Greensand near Cambridge, was long supposed to be a Sponge; but his more recent discovery of two specimens which had been but little changed by fossilization, led him to suspect their Foraminiferal character; and this suspicion has been fully borne out by the careful examination made of their structure by Dr. Carpenter, to whom he committed the inquiry, and by whom, with his concurrence, the name *Parkeria* was assigned to the genus. The second, which was obtained by the late Mr. W. R. Loftus from "a hard rock of blue marly limestone" between the N.E. corner of the Persian Gulf and Ispahan, bears so strong a resemblance in its general form and mode of increase to the genus *Alveolina*, that its Foraminiferal character was from the first recognized by its discoverer; but as all the specimens brought by Mr. Loftus had undergone considerable alteration by fossilization, their minute structure, though carefully studied by means of transparent sections, could not in the first instance be satisfactorily made out. When, however, Dr. Carpenter's investigation of *Parkeria*, with the full advantage of specimens but little changed by fossilization, revealed the very remarkable plan of its structure, the investigation of this type was resumed by Mr. Brady (who assigned to it the name *Loftusia*), with the new light thence derived; for as transparent sections of infiltrated *Parkeriæ* furnish a middle term of comparison between specimens of the same type which retain their original character, and transparent sections of infiltrated *Loftusiæ*, the last-mentioned can now be interpreted by reference to the preceding; so that the obscurities which previously hung over their minute structure have been almost entirely dissipated.—The description of the structure of *Parkeria* in this memoir is by Dr. Carpenter, and that of the structure of *Loftusia* by Mr. H. B. Brady; but each has gone over the work of the other, and can testify to its correctness.

The specimens of *Parkeria* which have been collected by Professor Morris* are spheres varying in diameter from about ¾ths of an inch to about 1¼ inch. The character of their external surface differs considerably in different individuals; but the author gives reason for believing that it was originally tuberculated, like a mulberry, and that the departures from this have been the result of subsequent abrasion. The entire sphere is composed of a great number of concentric layers, all of which, except the innermost, are arranged with very considerable regularity around a central "nucleus," which consists of five chambers, disposed in *rectilineal* sequence; thus unmistakably indicating the Foraminiferal character of the organism, which might otherwise have remained in doubt, on account of the entire divergence from any known type presented in the structure of the concentric layers. The first of these layers is moulded, as it were, on the exterior of the nucleus, and partakes of its elongated form; but the parts of every additional exogenous layer are so arranged as to bring about a gradual approximation to the spherical form, which is afterwards maintained with great constancy. Each layer may be described as consisting of a lamella of "labyrinthic structure" (that is, of an assemblage of minute chamberlets or cancelli, whose cavities communicate freely with one another), separated from the contiguous lamellæ by an "interspace," which is traversed by "radial tubes" that pass from each lamella to the one external to it. All these structures, in common with the chamber-walls and septa of the "nucleus," are built up by the *aggregation of sand-grains of very uniform size.* These sand-grains are found to consist of *Phosphate of lime*, and they seem to be united by a cement composed of *Carbonate of lime*, which was probably exuded by the animal itself. Although there is a very general uniformity in the thickness of the successive layers, the proportion of their several components varies considerably in different parts of the sphere. In those which immediately surround the nucleus, the solid lamellæ, which are composed of labyrinthic structure, are comparatively thin; whilst the "interspaces" which separate them from one another are very broad, so that the "radial tubes" which traverse these interspaces are very conspicuous. As we pass outwards, we find the "labyrinthic" lamellæ increasing in thickness, whilst the breadth of the interspaces diminishes in the same degree, until we meet with layers in which the "interspaces"

* Since this Memoir was completed, the Author has learned that Mr. Harry Seeley of Cambridge has collected several specimens of this type, and has been studying it independently with a view to publication. And Mr. Henry Woodward has placed in his hands a specimen from the Upper Greensand in the Isle of Wight, which is not less than 2¼ inches in diameter. It is interesting to remark that the "nucleus" of a smaller specimen from the same locality consists of a considerable number of chambers arranged in a *spire;* the structure of its concentric spherical layers being exactly the same as in the specimens described in the text.

are almost entirely replaced by labyrinthic structure. With this increased development of the labyrinthic structure in the concentric lamellæ themselves, we find it extending between one lamella and another, as an investment to the radial tubes; thus forming "radial processes" of a sub-conical form, which occupy a considerable part of what would otherwise be the "interspaces" between the successive lamellæ. Still every lamella is separated from that which invests it (except where brought into connection with it by its radial processes) by a system of cavities, which are in free communication with each other, and which may be collectively designated the "interspace system;" and from this system the labyrinthic structure of the investing lamella is entirely cut off by an impervious wall which bounds it upon its *inner* side; whilst its cancelli open freely upon the *outer* side of the lamella, into what, when it is newly formed, is the surrounding medium, but, when it has itself been invested by another layer, into its "interspace system." In the larger of the two non-infiltrated specimens which have furnished the materials for the present description, the number of concentric layers is 40, and their average breadth about 1–65th of an inch.

The Author discusses the mode in which this composite structure was formed; and comes to the conclusion that the production of each new layer was probably accomplished by the instrumentality of the sarcodic substance, which not only filled the cancelli of the preceding layer, but projected beyond it; that the radial processes were first built up like the columns of a Gothic cathedral, and that their impervious investing-wall spread itself from their summits, so as to form a continuous lamella over the sarcodic layer, in the manner that the summits of such columns extend themselves to form the arched roof of the edifice; and that on the floor of the new layer thus laid the partitions of the cancelli were progressively built up by the agency of the sarcodic substance conveyed to the outer surface of that floor through the radial tubes. The author further argues, from the analogy of living *Foraminifera*, that, notwithstanding the indirectness of the communication between the cavitary system of the inner layers and the external surface, the whole of that system (consisting of the labyrinthic structure of the successive lamellæ, and of the interspaces which separate them) was occupied during the life of the animal by its sarcode body.

The *plan of growth* in *Loftusia* is stated by Mr. Brady to differ extremely from that of *Parkeria*, whilst its *intimate structure*, on which its physiological condition must have depended, is essentially the same; thus affording a conspicuous example of the validity of the principle of classification already referred to. This difference is indicated by its shape, which closely resembles that

of many *Alveolinæ* and *Fusulinæ;* being a long oval, frequently tapering almost to a point at either end, though sometimes obtusely rounded at its extremities. Of two large and perfect examples in the collection of the late Mr. Loftus, one measures 3¼ inches by 1 inch, the other 2¼ inches by 1¼ inch. A transverse section at once indicates that the plan of growth is a spiral, formed by the winding of a continuous lamina around an elongated axis; the general disposition of the chambered structure being very similar to that which would be produced if one of the simple *Rotalians* were thickened and drawn out at the umbilici. The space enclosed by the *primary lamina* is divided into chambers by longitudinal septa, which may be regarded as ingrowths from it, extending, not perpendicularly (as in *Alveolina*), but very obliquely. The chambers, separated by these principal or *secondary* septa, are long and very narrow, and extend from one end of the body to the other. Their cavities are further divided into chamberlets or cancelli by *tertiary* ingrowths, which are generally at right angles to the septa, or nearly so, but are otherwise irregular in their arrangement. No large primordial chamber, such as is common among Foraminifera, has been yet discovered in *Loftusia;* but its absence cannot be certainly affirmed. In fully-grown specimens the turns of the spire, which succeed each other with tolerable regularity at intervals of from $\frac{1}{50}$th to $\frac{1}{30}$th of an inch, are usually from twelve to twenty in number; but as many as twenty-five have been counted in one instance, and a yet larger number might not improbably be met with. The *spiral lamina* and its prolongations, forming the accessory skeleton, are all constructed of almost impalpable grains of sand, which is proved by analysis to have consisted of *Carbonate of lime*, united by a cement of the same material.

The Author then describes in detail the several components of the fabric of *Loftusia*, and compares them with the corresponding parts of *Parkeria*. The continuity of increase of the spiral lamina always leaves an open fissure between its last-formed margin and the surface of the previous whorl; and through this aperture the whole system of chambers included within its successive laminæ communicates with the exterior through the passages between their cavities, which are left in the building up of the septa. As already explained, the labyrinthic structure takes its origin from the *inner* surface of the impervious spiral lamina, the septa being directed towards the central axis. These ingrowths have in many instances the form of tubular columns, which traverse the chambers in a radial direction (*i. e.* perpendicular to the spiral lamina), terminating either on the septum of the previous chamber, or on the exterior wall of the preceding whorl of chambers. But these tubes do not seem to be homologous with the "radial tubes" of *Parkeria*, whose relations differ in important particulars. The range of variation

in a number of specimens, as to the amount of the "secondary" and "tertiary" ingrowths which divide and subdivide the chambers in *Loftusia*, is very great. The principal office fulfilled by this accessory skeleton seems to be that of a support to the primary spiral lamina, imparting the necessary solidity to the organism. The degree of sub-division of the chambers into chamberlets seems to have little bearing on the general economy of the animal.

The Author attempts to determine from the other Foraminifera of which the remains are found associated in the same Limestone with those of *Loftusia*, what was its probable Geological age, and under what conditions it was deposited; and he thence draws the conclusion that the rock belongs to the lowest portion of the Tertiary period, presenting a microscopic Fauna very similar to that of some of our Miliolite limestones, but richer in the small arenaceous Rhizopods; and the sea-bottom was a soft Calcareous mud, lying at a depth of from 90 to 100 fathoms.—*Read before the Royal Society, Thursday, April 22nd.*

VII.—*The Microscope in Silkworm Cultivation.* By M. Cornalia.

The report which M. Pasteur recently published, and which he was so good as to send me, indicates the great progress which has been made in this direction. Supported by a great number of facts, expressed with an order and clearness which an experienced observer can alone obtain, M. Pasteur has established it as an axiom that the healthy egg of caterpillars, which are themselves healthy, and have been carefully cultivated, should not only furnish a good product, but also healthy caterpillars, which in their turn should deposit healthy eggs. He thus proclaimed, with the authority of his word, the utility of the microscope, which utility I myself and my fellow-countrymen have contended for on all occasions when experiments or observations enabled us to do so.

Indeed, for several years some of my friends have had marvellous crops of cocoons by selecting eggs free from corpuscles which I had selected for them after very careful investigation. With a microscopic examination, limited to the eggs, we make only a half experiment. This method is imperfect, and the incomplete success resulting from its employment may be attributed (excepting certain bad processes of culture) to examination for corpuscles in the eggs only, for every healthy egg does not necessarily produce a healthy moth. These facts are evidenced by the fact that eggs attacked in the proportion of 4 per cent. if proceeding from one of our families of moths, or 8 or 9 per cent. if from one of the Japanese

races, give very mediocre results. In fact, the corpuscles which I have often insisted on, are the appreciable characters of the disease; but the eggs may be attacked by the original disease without having these microscopical features. In examining the eggs of a corpuscular female, in which they were disposed in chaplets in the ovaries, all the eggs were not found charged with corpuscles.

In order, then, to make a definitive experiment to guarantee the healthiness of the eggs, there is nothing like examining the moths before or after they have deposited their ova, in order that we may reject all those eggs proceeding from tainted parents. This mode, the most rational, although the most difficult of execution, which M. Pasteur has suggested, and which *I believe to be alone capable of regenerating our races of worms*, was attempted last year at Milan with complete success. The results I published in my letter to the 'Perseveranza;' but I ask permission now to describe in detail some of the results which the experiments of 1868 in Lombardy enabled me to formulate.

In the month of June, 1868, I received from Zara a *chambrée* of cocoons of the ancient Italian race, cultivated on the Dalmatian coast, not far from the shores of the Adriatic. These cocoons, about one kilogramme, contained three chrysalides alive. Some of these chrysalides, which I soon examined, and which were not yet perfect, exhibited no trace of the corpuscles. It was then that the idea occurred to me of applying M. Pasteur's method to the eggs obtained from healthy moths grown with every care . . .

My friends the Marquis Crivelli and M. Bellotti undertook this experiment. The moths, when hatched out, had a most deceptive appearance, and, when examined by these gentlemen, were found to be free from corpuscles; here there was a perfectly healthy egg, the product of healthy parents, which gave promise, not only of a large produce in cocoons, but even of a healthy crop of moths and of eggs for the culture of the year 1869.

M. Crivelli selected Inverigo, in Brianza, to "bring up" these eggs, in order to surround them with all the necessary care. He divided the eggs into three portions; one of these parcels was given to a peasant in the village, another was reared in his own garden, and the third was sent to a distant locality.

It is necessary to state that the mode of "education" adopted by the Marquis was an extremely careful one; general hygienic conditions being carefully attended to, and the locality, which had some time ago been used as a hospital for cholera patients, having been fumigated with chloride of lime. Within a radius of 500 mètres, no other silkworms were cultivated. Moreover, the locality abounded in mulberry-trees—this fact being of importance,—for had the leaves been imported from other localities, they might have been tainted with corpuscles of diseased caterpillars.

The cultivation of the three batches proceeded excellently, as on the estate of Inverigo, where the Marquis raised 210 ounces of eggs, of which no more than two per cent. were diseased. From these 210 ounces he obtained 10,176 kilogrammes of cocoons, a mean of 48 kilos. to the ounce. The three batches of eggs from Zara did still better; for they produced a maximum of cocoons equal to 62 kilos. per ounce.

As may be imagined, the Marquis set apart for the next year the eggs from the last-mentioned quality, and he set to work with ardour, and with great hopes of excellent results. But all his exertions were not followed by equal success.

The examination of the chrysalides responded exactly to what might have been predicted; that is to say, that all three batches were equally healthy. The microscopic examination of the moths, however, gave quite a different result. Those which had been reared in the village and those in the Marquis's garden were diseased; but those which had been sent to a distance and which were brought up in the isolated house were perfectly healthy. Not one of these last presented any corpuscles, neither in leaving the cocoon nor in depositing ova, nor in decay, nor after death.

Here there is a decisive result; for the eggs were the same and the education of the three batches was alike, save in certain circumstances, on which it is important to insist. All had the same abundance of air, all were equally *chambrées*, all had excellent food. The peculiar circumstances relate only to the conditions of contagion—to the transport of corpuscles. In fact, the healthy moths were those which had been reared under circumstances of isolation, in places previously disinfected, and where the worms had been fed with leaves equally isolated.

Here there is what is essential to obtain certain results. To the ordinary precautions of "education," conducted with all possible attention as to temperature, aëration, and abundance of food, it is necessary to add isolation of the chambers by a cordon of at least 500 mètres radius, and *healthy eggs, deposited by healthy moths*, cultivated with particular care in isolated localities, disinfected with chlorine, and having a certain "precocity,"* in order to obtain isolation.

The experiment has not been made on a very small scale; for M. Crivelli has been able to obtain 480 ounces of these perfect eggs; and it was in this harvest that he obtained the maximum of 62 kilos. of cocoons to the ounce.

M. Bellotti, to whom I had given the other portion of the healthy eggs, and who raised them at Varèse with his usual skill

* The object of "precocity" is to avoid the contemporaneity of exceptional and ordinary broods; to prevent the worms for the production of eggs being *à la bruyère* at the time when the ordinary broods are in their last moult—the period of the greatest development of corpuscles.

and care, also obtained a large produce in cocoons; but the moths which came from them contained corpuscles. *He had not isolated his chambers.*

This, then, is why in some localities, as the Apennines, in Dalmatia, and in Istria they have always good crops of cocoons and sound eggs. The localities are much more isolated than ours are. The hatching-grounds are at the summit of hills and in conditions most favourable to avoid contagion.

See what has occurred this year in Istria. For several years I have myself examined the eggs cultivated by MM. Villanova de Farra, not far from Trieste (they rear some thousands of ounces), and they have so far recognized the importance of my predictions, that they wished this year to carry out experiments on the subject. I therefore sent to them M. Gaddi, who has been accustomed to this sort of microscopic work in my laboratory. He set out with his microscope to Istria, and visited several localities. In the course of his travels he examined fifty-four different lots of cocoons, commencing with the examination of the chrysalides, in order to reject those which were diseased.

Out of fifty-four different batches, only five (Nos. 8, 11, 17, 35, and 49) exhibited 10 per cent. of corpuscles, and therefore these presented favourable chances of obtaining healthy moths. It is necessary to state that even in the same batch of chrysalides there might be different proportions of healthy and diseased specimens, according to the degree of maturity. The chrysalides just formed partook of the condition of the worm; these, which were many days older, partook more of the condition of the moth. In one case (No. 36) the chrysalides just formed showed only 4 per cent. of infected specimens; but, after some days, they presented as much as 70 per cent. of corpusculated specimens. Thus we may lay down the proposition that the chrysalides just formed exhibit the disease much in the same degree as the corresponding egg; those, however, which are near their transformation present the disease in a much more marked degree. Of the several lots examined, three only gave indications of healthy produce. The results of the examinations of these is given in the following Table :—

	Chryaslides.			Moths.			Eggs.		
	Number of individuals examined.	Diseased.	Per-centage of diseased.	Number of individuals examined.	Diseased.	Per-centage of diseased.	Number of individuals examined.	Diseased.	Per-centage of diseased.
No. 11	31	0	0	141	3	2	116	0	0
17	32	1	3	133	1	0·75	205	0	0
35	80	1	1·25	1268	18	1·5	215	0	0

In lot 35 of 1268 moths 345 were of the best character. Thirty-eight were less fine specimens, and 885 were of couples separated by the "cellular method." It is with these excellent ova that MM. Levi await the harvest of the ensuing year. M. Crivelli has been equally fortunate with the lot isolated in the manner before referred to.

It is difficult to establish a proportion between the disease as it appears in the egg and as it afterwards exhibits itself in the moths, because of the different periods at which the examination is made. If the examination be made too early, it may discover 0 per cent. in the chrysalides; 30, 50, or 60 per cent. in the moths; and, again, 0 per cent. in the eggs proceeding from these. These proportions have been found by M. Crivelli. The corpuscles are propagated with an incredible rapidity, and sometimes in the last moments of the life of the chrysalides, when the eggs are already formed—a fact which explains why a great number of corpusculated moths may present eggs which contain no corpuscles.

In the experiments in "cellular" breeding it has been found that the males hardly ever propagate the disease to the females. In the tables prepared by M. Crivelli, where the male was diseased and the female healthy, the eggs also were invariably healthy. Is it that the spermatozoa enter the ovum by a channel which does not allow the passage of the corpuscles? From observations which I have conducted, I deduce that the disease in the ova is to that of the moths as 1 to 10. Here are some examples of this:—

No. of observation.	Eggs.			Moths.		
	Number of eggs examined.	Number of eggs affected.	Percentage of disease.	Individuals examined.	Diseased specimens.	Percentage of disease.
1	50	4	8	20	16	18
2	50	3	6	20	12	60
3	75	7	9	15	14	95
4	45	4	8·9	20	17	85

From the foregoing remarks and general experience, I draw the following conclusions:—

(1). An egg, apparently healthy as to its microscopic features, may proceed from very unhealthy parents.

(2). An egg, healthy as to its characters under the microscope, may and does give ordinarily a long produce in cocoons, but it may be incapable of giving healthy eggs.

(3). The absolute health of an egg proceeding from healthy moths [which present only about 4 or 5 per cent. of diseased specimens] is an excellent indication of the capacity of an egg to produce

healthy moths, which in their turn shall be capable of producing healthy eggs.

(4). To assume this result, it is necessary to maintain all those hygienic and other conditions before mentioned.

Letter from Signor Cornalia to M. Pasteur, read to the French Academy, and published in the 'Comptes Rendus,' * *LXVIII., No.* 11, 1869.

* The original French is so obscure, and the repetitions are so numerous, that the translator has in many cases condensed and paraphrased M. Cornalia's remarks, without, it is hoped, modifying its sense. It may be mentioned also that M. Pasteur is spoken of in the third person, instead of the second, as occurs in the correspondence.—Ed. S. O.

NEW BOOKS, WITH SHORT NOTICES.

A History of the British Hydroid Zoophytes. By Thomas Hincks, B.A. in 2 vols. London: Van Voorst, 1868.—Mr. Hincks is so well known as an able and indefatigable explorer of the Hydroid Cœlenterates, that we naturally anticipated that his treatise on the British Hydroid Zoophytes would be a very complete and valuable monograph. Let us say, then, in the first place, that we have by no means been disappointed. The work which Mr. Van Voorst has just issued fills a void which existed too long in our literature, and in our opinion takes the place which was once occupied by Johnston's 'History of the British Zoophytes.' Of course Mr. Hincks has drawn largely on the results of his own inquiries in preparing this treatise; but he has not on that account neglected the valuable researches of Allman, Busk, Strethill Wright, Alder, Sars, and Van Beneden. Of the two volumes, the first embraces the text, and is divided into the general remarks on the group and the descriptive portion; the second includes the Plates, which have been executed by Mr. Tuffen West. Those who have paid any attention to the study of the Cœlenterata are aware how extensive is the terminology applied to the class Hydrozoa; and though Professor Greene has simplified the whole as much as possible in his excellent manual, it is nevertheless tough work for the beginner to master. Readers will therefore be very glad to learn that Mr. Hincks has considerably reduced the list of technical terms, and has employed only those which are essential to the recognition of species. Indeed, he confines himself to twenty-one terms, all of which are briefly and clearly defined. In most cases these are similar in significance to the expressions employed by Huxley and Allman; but the term Gonophore is used in a more definite sense than that in which the latter uses it. As Mr. Hincks remarks, "As employed by Allman, the gonophore is sometimes the reproductive bud *with its ectotheca*, and sometimes it contained zoöid, whether fixed or free. To me the gonophore is the whole bud; and the sexual zoöid developed in it, whether as a fixed sac or a floating polypite, is the gonozoöid." Having explained his terminology, the author then proceeds to deal with the anatomy and physiology of the group. This he does in an introductory chapter of more than forty pages, illustrated by numerous woodcuts intercalated in the text. Rate of growth, *Phosphorescence*, geographical distribution, methods of collecting, are points also treated on in this chapter. Not the least interesting of the author's remarks are those on the subject of development, in which he traces the phases of ovum and *planula*.

The method of classification is simple and convenient, as it is based on rather broad characters, and is upon the dichotomous scheme. The whole of the order is divided into two sections:

Athecata, Hydroids with a polypary, but without calycles; and *Thecaphora*, those with true calycles. There follows under each of these heads an analytical key on the binary plan, by which the genera are indicated. The species are then described at length, as well as the genera in the more taxological portion of the work.

The author's notions on the principles of general philosophical classification are very forcibly expressed, and will be seriously questioned by many thoughtful naturalists. We admit that he has strong arguments in favour of uniting all the naked-eyed Medusæ to the Hydroida. But then there is the important fact of the independent development of Lizzia (a species which directly reproduces itself), which cannot be overlooked. The author's reversion to the use of the terms Siphonophora and Discophora seems to us to be objectionable, if from nothing else, because these terms are less significant of morphological characters than the terms Calycophoridæ and Physophoridæ of Huxley. We fancy that Mr. Hincks, in trying to classify these organisms for the convenience of the student, has in some cases sacrificed a natural for a more arbitrary method. But of course this is a question on which opinions must and will differ.

The accounts of the genera and species, the synonymy, habitats, bibliography, and general natural history are all excellent. The plates are sixty-seven in number, and though in some cases a little flat and wanting in artistic beauty (owing, we believe, to having been printed from "transfers"), they are, on the whole, admirable representations, faithful and well arranged. With a good microscope and this volume, the naturalist who can spend a month at the sea-side is greatly to be envied.

Facts and Arguments for Darwin. By Fritz Müller. With Additions by the Author. Translated from the German by W. S. Dallas, F.L.S. London: Murray, 1869. — Those who still find a difficulty in recognizing the force and importance of the law of "natural selection" should read this work of Müller's with care. It certainly is one of the most powerful appeals to the inflexible logic of facts that has been made, with the exception of Darwin's own reasonings. The author, with the help of a multitude of excellent woodcuts, goes into the whole question of the morphology and development of the Crustacea. He thus lays before his readers a host of facts of the most complex character. He attempts to explain and unravel these by means of the old teleological idea, and fails. He then applies the Darwinian doctrine, and shows that it affords—within limits—a satisfactory solution. Certainly his explanation of the relation of the adult *Tanais Dulongii* to the Zoeæ forms is most remarkable and significant. Mr. Dallas has given us a very readable translation, and has done good service to science by introducing Müller's work to English readers.

Remarques sur le Développement d'une Planariée Dendrocœle, le Polycelis lævigatus. Par Leon Vaillant. Montpellier: Boehm et Fils, 1868. —This memoir, which is now published separately, originally appeared in the Proceedings of the Academy of Sciences of Mont-

pellier. The author has gone tolerably minutely into the history of the development of this planarian, and has recorded the different phases in a large quarto lithographic plate. From his researches he concludes that it is doubtful whether there is such a thing as metamorphoses among Planariæ. Hence he remarks that the singular infusoria described by Joh Müller and Claparède as the larvæ of Planarians can hardly have any relation to this group at all.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Germinal Vesicle in the Egg.—In our last Number we gave a translation of M. Gerbe's important paper on the eggs of the Sacculinæ. Since the publication of that note M. Balbiani has stated that he himself, long ago, pointed out the existence of two vesicles in the ovum of various animals, and he objects to M. Gerbe taking the credit of that discovery to himself. In reply, M. Gerbe disclaims any idea of claiming that part of the discovery as his own. He says, "What I wish to establish is that in the ovule of the Sacculinæ, as in all species whose ovum has a cicatricule, the vesicle which has for so long a period been known as the Germinal vesicle, is really that around which are grouped the materials destined for the development of the embryo, and which consequently should preserve the name that the first observers gave to it. I also intended to establish that the second vesicle, that around which I have seen the nutrient matter develop itself, that is to say, the analogue of the yelk in birds, can have no other function than to accumulate this element." He contends that both of these propositions are correct, inasmuch as they are not based on preconceived ideas, but on careful examination of ova from their origin to their "maturation."—*Comptes Rendus*, March 15th.

The Structure and Development of the Spermatozoa in Fishes have been studied by M. Owsiannikoff, who has presented a memoir on this subject to the Imperial Academy of St. Petersburg. The spermatozoa are far more complex in structure than is generally supposed by those who follow Kölliker's account. The author investigates the zoosperms of the *Salmo salar*, *S. fario*, *Coregonus*, and some forms of perch. The seminal glands have in their interior the structure of compound glands. They are formed of connective tissue, blood-vessels, nerves, epithelium, and spermatozoa; and, as in other glands, the principal element is the epithelium. The epithelium cells, which have the ordinary cylindrical form, are placed in two rows, and are not separated from the rest of the tissues by any particular membrane. All of these possess a large white nucleus, which distinctly encloses a central corpuscle and protoplasm. The process of division of the cells is known. Cells may be seen which have acquired a considerable development, and which enclose from ten to fifteen secondary cells without losing their form.

These are the spermatozoa in the young state; the nucleus becomes the head, and the protoplasm which surrounds it becomes the tail. In the salmon the adult spermatozoa have an elongated head, pointed in front and wide behind, like a fish's head, or like an ace of hearts on cards. This head is composed of two parts, which are separated one from the other by a superficial groove. Each half is rounded behind in the form of a club. There is behind the head an enlargement which seems to correspond to the body of certain other zoosperms, but which really has no distinctive character. The tail is very long, and its movements are not of a "bounding" character, but an undulatory vibration. The seminal fluid of fishes is at first fluid, but it soon coagulates and becomes gelatinous; but if this mass is broken up it becomes fluid anew. The author has even artificially fertilized the eggs taken from dead fishes, and in most cases with successful results. If water is added to the seminal mass the spermatozoal movements become very rapid, but if too much be added they cease quickly in most instances. Then the tail becomes invisible, even under the highest power. This disappearance he believes to be due to the sudden retraction of the tail, which becomes applied to the head; and he states that if it be carefully watched under high powers it will be seen that the tail is drawn up suddenly, and that the protoplasmic mass of the head becomes simultaneously enlarged. The employment of reagents, like indigo, carmine, &c., shows that the tail is composed of protoplasm, and that the disappearance of the tail is due to its being applied against and partly coiled around the head.

The Structure and Relations of the Ovum.—The Belgian Academy's prize for the best essay on the ovum in the different classes of the animal kingdom was recently awarded to M. Edouard Van Beneden. MM. Gluge, Schwann, and Poelman, who made the award, have reported at length on M. Van Beneden's essay, which, by the way, extended over 442 pp. 4to. The development of the ovum has been described in the 'Trematodes, Cestoids, Turbellaria, Nematoids, Crustacea, Birds, and Mammals.' The reporters, while admitting the merits of the essay, have not hesitated to express their disapproval of certain parts. Indeed M. Gluge goes so far as to say that the part devoted to egg of the bird does not deserve any mention. The author's view as to the constitution of the ovum is that which he has already in part laid down in the communication published by him and M. Bessels in these pages, and it is thus expressed by M. Schwann:—"The general result at which the author has arrived is that the egg is in its origin a simple cell, whose nucleus is the vesicle of Purkinje, and whose nucleolus is the germinal dot of Wagner. The protoplasm which surrounds the nucleus completes the cell. But the primitive cell combines later with a deposit of nutritious matter, under the form of highly refractive globules, which he terms plasma. This plasma, which is variable and may be absent (as in *Cucullanus*), combines with the cell-egg in a different manner in the different classes of the animal kingdom. The mode of development of the cell-egg is the same in all animals: in those which are *germigenous* and *vitelligenous*—that is to say, in which the work is divided between

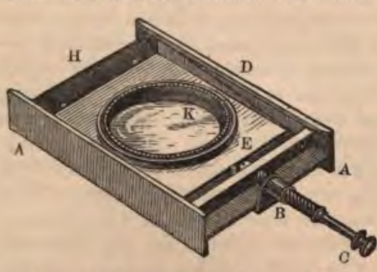
two glands or two different parts of the same organ—the development takes place in the *germigenous* portion; in all the higher animals it takes place in the ovarian tubes, of which the Grafian vesicles are a fraction. In these organs there is a liquid, which the author calls a protoplasmatic liquid, which holds in suspension nuclei with nucleoli. The nuclei divide, and each one accumulates round it part of the common protoplasm; and when thus the cellular layers are separated from each other, the cell-egg is completed. There is no vitelline layer in the commencement of the egg, but only this protoplasmic envelope round the nucleus. From these facts the author draws the conclusion that it is not the vesicle of Purkinje which is formed in the first place; but these vesicles and the protoplasm are formed simultaneously, and the latter condenses later round each nucleus. Among the points of interest in this memoir of M. Van Beneden is the discovery of an actual *micropyle* in the ovum of the cow.—See *L'Institut*, March 31st.

Mechanism of Fecundation in Lepidoptera.—Under this title a very interesting paper by M. Balbiani appears in the '*Comptes Rendus*,' March 29th. The author describes the reproductive apparatus in much detail, and he points out the existence of a peculiar depurating function on the part of the copulative pouch. He believes that the structures he describes are used to separate the zoosperms from foreign bodies which they may become associated with, and which would prove injurious to the ovum.

Function of the Latex on the White Mulberry.—The above-mentioned '*Compte Rendu*' contains also a valuable paper by M. Faivre on this subject. The author concludes that the latex is not simply an excretion; it is the alimentary matter of the plant.

NOTES AND MEMORANDA.

Ross's Reversible Compressorium for High and Low Powers.—This instrument consists of a metal frame A A, in one end of which there is a quick-acting screw B, with milled head C, which drives forward a fork-piece with wedge-shaped sides D; this fork-piece moves on the raised sides (also wedge-shaped) of a brass plate E, kept separated from the plate H of the metal frame A A by two springs between them, so that, when the screw B is moved forward, the brass plate E, by the action of the wedge D, is made to approach to the metal plate H of the frame A A. In each of these plates, but on opposite sides, is



screwed one or other of a series of brass rings K, having cemented on their surfaces a thin glass disc of suitable thickness. The ring with thin glass may be removed from either side of the compressorium to place the object in position, which it should just touch when replaced; and as the whole of the compressing arrangement is contained in the thickness of the metal frame, both sides of the object can be examined with equal facility.

The Belgian Academy's Prize.—Among the prizes proposed for the Concourse of 1870 by the Belgian Academy is one the subject of which may interest some of our readers. The subject (No. 4) is thus stated: "To make known the development of insects of one of the orders having complete metamorphoses, bearing especially on the least known phases of evolution." The value of the prize is 600 francs. Manuscripts should be sent in to the Secretary of the Academy at Brussels before the 1st of June, 1870. The author's name must not be attached to the MS., but must be given in a sealed envelope accompanying the memoir.

A New Micro-spectroscope, possessing special advantages, has, we hear, been devised by Mr. W. Crookes, F.R.S., and is made by Mr. Charles Collins. We have not yet examined the instrument, and we therefore reserve our opinion of its merits till we can speak with authority.

Messrs. Powell and Lealand's New Condenser was exhibited at the last meeting of the Royal Microscopical Society, and certainly is a very excellent though simple piece of apparatus. It consists of a hemispherical lens by which the diverging rays of a lamp are thrown in a parallel bundle and in a nearly horizontal plane beneath the object under examination.

The Lowest Form of Living Protoplasm.—A "Fellow" remarks that the *Amœba* is not the lowest form of animal life, though so frequently selected as such. Professor Huxley's *Bathybius* will probably in future take its place.

Desiccation of Rotifers.—A correspondent writes to ask us for information on this point. We trust that some of our readers will make a few experiments and give us the results. Some naturalists assert that rotifers may be placed on a glass slide in a drop of water and gradually dried by heat without destroying them, and that in this state they may be maintained for any length of time, a drop of water sufficing to revive them. Others as decidedly deny it. It might very readily be tested.

Does Boiling destroy Germs?—This question cropped up in the course of the Pasteur and Pouchet controversy on Heterogeny, and it appeared that there are some germs that are not destroyed by boiling, but which require a temperature some degrees (10° or 12°, we believe) above boiling. This is another simple problem for microscopists.

Spontaneous Generation.—We are informed that one of the

Fellows of the Royal Microscopical Society has been lately engaged in experiments on this interesting subject, and that he has discovered several most remarkable facts corroborative of Pouchet's views. Indeed, we believe he has watched the progress of a bacterium in its passage into a ciliated infusorium—*Kolpoda* or *Paramecium*.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.†

King's College, 14*th April*, 1869.

The Rev. J. B. Reade, F.R.S. (President), in the chair.

The minutes of the last meeting were read and confirmed.

A list of donations which had been made to the library was read by the Secretary.

It was also announced that a number of papers written by the late Dr. W. B. Herapath, of Bristol, had been received from his widow, and that they were sent for distribution among those Fellows of the Society who might desire to possess them.

Mr. Slack announced that Mr. Crouch had presented to the Society one of his Universal Silver Side-reflectors; and also that Col. Hennell had presented, through Mr. Curteis, three slides of Diatomaceæ mounted on the weed; that Mr. W. T. Suffolk had made a donation of a water-colour drawing of *Plumatella repens;* and Mr. Collins five interesting slides.

A vote of thanks was unanimously passed to the donors above named.

The President then called upon Dr. Lionel Beale, F.R.S., to read a paper on "Protoplasm and Living Matter."

At the close of the paper the President announced that Professor Huxley would have been present at the meeting had he not been engaged elsewhere in the discharge of his duties as the President of another Society, whose meeting was being held that evening.

The President then invited Dr. Wallich to offer a few remarks on the subject of Dr. Beale's paper.

Dr. Wallich said he would content himself with briefly referring to one point only. He believed that theories upon the subject in question had been propounded with a degree of dogmatism which the ascertained facts did not warrant. After considerable study of deep-

* Secretaries of Societies will greatly oblige us by writing out their reports legibly—especially the technical terms—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

† *Report* supplied by the Secretaries.

sea deposits, he had not discovered any evidence to warrant the conclusions to which Professor Huxley had arrived. It must be remembered that the deposits, although brought up living from the bottom of the sea, would necessarily undergo certain changes after having been kept for some time confined in a vessel. Their appearance would not be the same as when first brought up.

With regard to the organic matter called *Bathybium*, he had examined deposits in the gutters, and had seen the same characteristics in those as in the deep-sea deposits. A very favourable locality for collecting these deposits was at the outlet of the Metropolitan Main Sewer at Crossness.

Mr. Slack said he should like to have some explanation of one or two points mentioned in Dr. Beale's paper. Dr. Beale speaks of the total difference between matter in the living and matter in the dead state. Now, this "total difference" may be taken to include chemical difference, of which evidence does not appear. The nutrition of the higher animals consisted in the assimilation of such matters as fibrine, casein, gluten, and certain hydrocarbons, and these substances belonged to the same chemical series as the bodies composing the animal tissues.

He would also inquire why Dr. Beale asserts that when chemical changes occur in the body they totally differ from those which take place in the laboratory? (Dr. Beale here signified his dissent from Mr. Slack's inference.)

Further, they had been told by Dr. Beale that the living body supplies nothing analogous to the complicated apparatus of a chemist's laboratory. Now, the apparatus of a chemical laboratory comprises the means for raising the temperature of the substances to be experimented upon. If it was wished to obtain destructive decomposition, great heat was employed. If it was desired to separate certain organic units from a complex body, much less heat is employed; and living organisms supply the temperature fitted for actions of this description.

Again, the chemist employs filters and dialysers, which give a preferential entrance or exit to certain things; and in this he only clumsily imitates the operations carried on by organic membranes and tissues.

He would ask Dr. Beale whether he had not gone too far in protesting against those who object to the undefined use of the term "vital force?" Until we were told exactly what "vital force" did, and how we could distinguish its action from that of other forces, we could not use the term with any precision. Many organic substances which we were told a few years ago could only be formed by "vital force" were now made in the laboratory by purely chemical means, as Wöhler, Berthelot, and others had shown.

Mr. Breese said that, looking at science in its ordinary form, it might be possible to dogmatize too much on the vital principle. He would ask Dr. Beale one question, however. In the human form we know little of nervous force. With the brain at one end and the terminal nerves at the other, nothing is known of the means by which communication is carried on between them. He should be glad to

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know what part electrical and chemical force played in the nervo system?

Mr. Roberts said there was one peculiarity of living membran which had not been mentioned. It was this—that wherever there a living membrane the diffusion of salts is stopped; directly it is de the salts penetrate it.

Dr. Murie thought there was a tendency in the present day revive by-gone modes, not only of dress but of thought; and adduc the old scientific sects of the Solidists and Humouralists as represen ing views which have reappeared. The word "vitality" he thoug could not be dispensed with. We possess very indefinite notions the higher forms of life, and the time has not yet arrived when can say that the phenomena of the higher and lower forms of life a one and the same. He wished that Dr. Beale had not confined h remarks so exclusively to the lower organisms.

The Rev. Mr. Mitchell thought a very false analogy had been ma between crystalline forces and vital forces. He could see no analog in anything belonging to the structural form of crystals to tho unknown processes which produce a living protoplasm, or those extr ordinary combinations which we call organized bodies.

The question is, whether we see throughout nature, in the lowe forms of organic life, anything analogous to crystalline force. It said that a crystal grows; but between the growth of a crystal a that of the lowest form of organic life there is a striking differen The crystal is homogeneous in its internal structure; but when take the Foraminifera, we notice the power their protoplasm possess of taking hold of silica and carbonate of lime, and building them into structures as unlike crystals as they can possibly be. Th tendency of crystals is always to have plane surfaces, the diamo being the only apparent exception, but he believed it to be on apparent; whereas in the Foraminifera you find the law of pla surfaces set aside, and in their place the most beautiful curviline forms which can be devised. Again, he could not see, because we c make lenses and glasses according to our will, how he was indebted chemical action in the creation of such a structure as the eye. I could not help thinking that some higher force than that of me chemical attraction had operated in producing such a structure.

Dr. Kelly would like to know where the exact line is dra between vital and chemical force. For instance, you may have close proximity an epithelial cell charged with vital force, and ne the surface one containing dead matter. He wished to know wheth there was any correlation between the vital and the physical forc and whether matter in certain states is to be called vital, in othe physical and chemical.

Dr. Beale, in replying to the various remarks which had be made, said that the great point had been hit by Dr. Kelly in h inquiry as to whether the living matter shades gradually or abrupt into that which is formed. He (Dr. Beale) believed, that while appears to shade gradually, it really passes abruptly.

With reference to the remark of Mr. Breese about electricity, he (Dr. Beale) might be willing to admit that nervous force was electricity; but he did not think that would account for the phenomena of all the nervous system. The difficulty still remains as to what sets the electricity free. You cannot conceive of nervous action without conceiving nervous organism; and, looking at the organism of the nerves, he thought they could not be formed by physical causes. The means by which the nerves had been laid down cannot be explained physically.

On the question of transition, he must confess that he was of opinion that there is no transition from the organic to the inorganic. A good deal is said about spontaneous growth. He believed that spontaneous growth was utterly inconceivable to any one who has watched the phenomena going on in the amœba.

He could conceive living forms so minute as to evade inspection by the highest powers of the microscope. He could not believe that there was such a thing as the fortuitous concourse of elements making living forms.

The President said the last observation which Dr. Beale had made reminded him of a remark made by Dr. Milner when asked if he could refute Bishop Berkeley's theory of matter. He replied, "I cannot answer it. It contradicts common sense, and there must be great nonsense somewhere." He thought that a similar answer had been given by Dr. Beale in his paper to those theories with which he had been dealing.

A vote of thanks was then given to Dr. Beale for his paper.

The President announced that the following papers would have to be taken as read:—"On the Proboscis of the Blow-fly," by W. T. Suffolk, Esq.; and "On some New Infusoria from the Victoria Docks," by W. S. Kent, Esq.

The meeting was then adjourned to the 12th of May, when a paper will be read by B. T. Lowne, M.R.C.S., "On the Structure and Functions of the Rectal Papillæ of the Blow-fly."

After the meeting, Messrs. Powell and Lealand exhibited frustules of *Amphipleura pellucida* under their 16th-immersion lens, and with their new method of oblique illumination, which brought out the striæ most distinctly.

Donations to the Library and Cabinet, April 14, 1869:—

	From
Land and Water. Weekly	*Editor.*
Scientific Opinion. Weekly	*Editor.*
Society of Arts' Journal. Weekly	*Society.*
The Student	*Publisher.*
Journal of the Linnean Society, No. 49	*Society.*
Journal of the Quekett Club	*Club.*
Popular Science Review, No. 31	*Editor.*
Water-colour Drawing of *Plumatella repens*	*Mr. Suffolk.*
A Silver Side-reflector	*Mr. Crouch.*
Three Slides of Diatoms, in situ	*Colonel S. Hennell.*
Five Slides, various	*Mr. Chas. Collins.*

The following gentlemen were duly elected Fellows of the Society :—

Marshall Hall, Esq.
Frederick Lloyd, Esq.

The Annual Soirée of the Society was held at King's College on the 31st March last. By the courtesy of the College authorities, all the available room in the building was thrown open to the visitors. Upwards of 1000 ladies and gentlemen, comprising the Fellows of the Society and their friends, were present during the evening. The great hall on the ground-floor was appropriated almost exclusively to the display of instruments by the following makers :—Messrs. R. and J. Beck, Mr. J. Browning, Mr. Chas. Baker, Mr. Bailey, Mr. C. Collins, Mr. Crouch, Messrs. Horn and Thornthwaite, Mr. J. How, Mr. Ladd, Mr. Moginie, Messrs. Murray and Heath, Messrs. Newton, Mr. J. T. Norman, Messrs. Powell and Lealand, Mr. Thos. Ross, Mr. Steward, Mr. Stanley, Mr. J. Swift, and Mr. E. Wheeler. The small portion of the room not used by the makers was occupied by geological and mineralogical cabinets, kindly lent for the occasion by Prof. Tennant, F.G.S. The walls of the various apartments, through the kindness of Dr. Beale, Prof. Rymer Jones, Messrs. Mummery, and W. T. Suffolk, were adorned with various coloured diagrams.

In a theatre in the lower corridor, Mr. J. How exhibited, at intervals in the course of the evening, Dr. Maddox's photomicrographs by oxyhydrogen light; the oxyhydrogen polariscope; and the kaleidoscope by oxyhydrogen light; and in another room, Mr. C. J. Woodward, with his new apparatus, displayed the interesting phenomena of "the cohesion figures of liquids."

On the upper floor, the museum of George III. with its varied physical apparatus and mechanical models, and the Natural History Museum, were opened to the inspection of the company; the remainder of the rooms, excepting those set apart for refreshments, being occupied by the microscopes of the Fellows, and visitors, and by the Society's instruments. A collection of about twenty early microscopes, partly the property of the Society and partly the property of Mr. Williams, was exhibited in one of the rooms of the library. Among these was the Lucernal microscope, with specular iron as the object; and Martin's fine instrument, the object displayed being the iridescent crystals of bismuth, shown in a field of unusual size.

Without instituting an invidious comparison between the objects displayed by the several exhibitors, special mention may be made of a novel and highly-attractive exhibition by Mr. Gilbertson of crystals of sulphate of copper and magnesia in a polarizing microscope, the prism and selenites of which rotated by the mechanical agency of clockwork. By the kind permission of Dr. W. B. Carpenter, a chart, illustrative of the recent deep-sea dredgings, undertaken by him in conjunction with Dr. Wyville Thomson, was suspended in the "Marsden" Library. Dr. Carpenter also lent a number of slides, containing objects which had been dredged at various depths, among which were the following :—A "fragment of a shell of Brissus," found at a depth

of 650 fathoms; *Ophiocoma granulata*, at a depth of 530 fathoms; *Rhabdammina*, at the same depth; "Tubes of Annelides, composed of Globigerinæ," at 650 fathoms; and *Polycystina*, dredged at the same depth; and also three slides, containing "Trochamina incerta on Saccamina sphærica;" "Saccamina sphærica;" and "Astrorhiza limicola" from Professor Sars.

Mr. W. Chandler Roberts, of the Royal Mint, showed a very attractive object designated "Barton's buttons," consisting of fine lines ruled on gold, producing colours equalling the diamond in brilliancy. Mr. Jabez Hogg exhibited a variety of Mr. Sorby's crystals, many of them remarkable for their very delicate structure; and also a longitudinal section of the eye of a Mantis, by Prof. R. Jones. Mr. F. W. Gay exhibited the larvæ of a new nudibranch from the Victoria Docks, found by Mr. Kent, who has named it *Embletonia Grayii*. Dr. Millar had some beautifully-prepared specimens of marine Algæ, mounted and presented to the Society by Mrs. Clark, of Whitby. Mr. Chas. Tyler showed some slides of the spicules and gemmules of sponges; we noticed *Hyalonema mirabilis*, *Dactylocalyx subglobosa*, *Prattii* and *pumicea*. The Rev. Dr. Timins displayed portions of the posterior wing of some foreign locusts and crickets. Mr. Henry King, some insects and parts of insects in fluid. Mr. Henry Lee, a series of slides to illustrate the anatomy of Star fishes. Mr. J. Wight, *Arachnodiscus Ehrenbergii*, in situ. Mr. S. J. McIntire, living specimens of *Chelifer Latreilei*. Mr. Suffolk, lips of the blowfly. Mr. Lowne, viscera of a fly. Mr. T. C. White, the gizzard of *Blatta orientalis*. Mr. Kent, living and mounted specimens of the *Hydrachnidæ*, both in the perfect and larval state. And Mr. J. Slade, circulation in the frog's foot, under the influence of Worrara poison.

An object which, though not microscopical, attracted considerable attention, was the curious mechanical toy called the "piping bullfinch," which in the hands of Mr. How discoursed sweet music for the entertainment of the visitors.

WALTER W. REEVES,
Assist. Secretary.

QUEKETT MICROSCOPICAL CLUB.*

At the ordinary meeting, held at University College, March 19th, Arthur E. Durham, Esq., F.L.S., President, in the chair,—thirteen new members were elected, and eleven gentlemen were proposed for membership: the Rev. E. C. Bolles, of Portland, Maine, U.S.A., and M. Alphonse de Brebisson, of Falaise, Normandy, were also unanimously elected honorary foreign members of the club. A number of presents to the library and cabinet were announced, and votes of thanks to the donors were passed. Mr. W. T. Suffolk read a paper "On a Method of Drying Objects for Mounting," and described the process and the apparatus employed. The object to be dried was first immersed in ether, and then placed in a closed vessel containing chloride of

* Report supplied by Mr. R. T. Lewis.

calcium; the water being taken up by the ether, and this in its turn by the chloride of calcium. By this means many substances could be perfectly dried in thin sections without detriment, sections of potato being mentioned as examples. A discussion took place as to the best form of vessel to be used for the purpose, and the most effectual means of closing joints against the escape of ether vapour; Dr. Matthews, the President, and Messrs. Breese, Hawksley, and Suffolk, spoke on the subject. Mr. Thos. F. Wight read a short paper "On a Method of Coating Glass Chimneys for Microscope Lamps," and which consisted 'n pouring a thin coating of liquid plaster of Paris into the chimney, ubbing off a small portion on one side only for the escape of the ight, and allowing the remainder to dry gradually. By this means a imple and very efficient shade and reflector were at once obtained. 'he President suggested that it would be better to apply the coating o the outside in order to preserve the whiteness of the reflecting urface; but some practical difficulties, from the cracking of the plaster y expansion of the glass, were mentioned by the author, and it was hen proposed by Dr. Matthews to obviate this by electrotyping the laster. Mr. J. Slade made a few observations relative to some slides f skin of Synapta and shell of Terebratula, &c., which he had pre-ented to the cabinet; and votes of thanks to the readers of the papers were carried unanimously. The President announced that the field excursions of the club would commence in April, and be continued fortnightly during the summer months. The meeting was concluded by a conversazione.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, March 9th, 1869. E. W. Binney, F.R.S., F.G.S., Vice-President, in the chair. Joseph Chesborough Dyer, Esq., was elected an Honorary Member of the Society.—Professor W. C. Williamson, F.R.S., exhibited female cones of *Araucaria imbricata* and fruits of *Magnoliæ*, ripened last summer in the vicinity of London. He also called attention to a communication from Mr. Moore, of Liverpool, to the last number of the 'Magazine of Natural History,' pointing out that the beautiful *Euplectella aspergillum* of the Philippine Islands does not grow attached to the side of a rock, as had often been supposed, but that its silky lower extremity is found plunged in soft sand or mud in deep water, whence it is obtained by dredging. "Additional Notes on the Structure of Calamites," by Professor W. C. Williamson, F.R.S. The author stated that, since the reading of his first paper on the subject, he had studied numerous beautiful sections of specimens collected and prepared by Mr. J. Butterworth, of High Crompton, near Oldham. In general these specimens had confirmed all the author's views on the subject, with some slight modifications. One specimen had occurred in which remarkable variations presented themselves in the form of the cells of the cellular tracts dividing the woody tissue into radiating wedges; and in another there were traces of a transition from the barred or *scalariform* structure of the vessels

seen in Mr. Binney's Calamites, to the *reticulated* one of the author's specimens. All Mr. Butterworth's sections afforded distinct evidence of the existence of medullary rays, even when the vascular tissue consisted of barred vessels; but the latter examples do not exhibit the large verticils of medullary radii characterizing the author's genus *Calamopitus*. Mr. Butterworth's cabinet had further furnished the author with the cone of *Calamopitus*, which proves to be much larger than Mr. Binney's cones of *Calamodendron*, as well as to exhibit numerous other distinctive features. The author proposes to make this cone the subject of another memoir. It is a true Cryptogamic spore-bearing organ, the spores of which resemble the tetra-spores of the Rhodospermous Fucoids in being lodged each in a separate cell. They exhibit no traces of Equisetiform elaters.

The additional evidence thus obtained convinces the author that in its structure and growth *the stem* of the Calamite has been exogenous, but the structure of the cone proves that the plant has not been, as Mr. Adolphe Brongniart supposes, a Gymnospermous exogen. It has combined the woody cylinder of an Exogen with the fructification of an Acrogen, a combination that has no existence amongst living plants, thus establishing a transition, through the modified *Coniferæ* of the coal measures known as *Dadoxylons*, from the Cryptogamic to the Phanerogamic forms of vegetation, meriting the attention of Mr. Darwin. The author pointed out that the *Dadoxylons* themselves were not true *Coniferæ* of the modern type, since none of their stems exhibited the true glandular pleurenchyma characteristic of that type. He also reviewed the attempts made to "restore" the Calamite, objecting to them as premature and, consequently, unsuccessful; and, further, gave reasons for believing that the fluted stems of Calamites bore verticils of slender branches and not merely of leaves. In conclusion, he called attention to the wonderful penetrating power of the cylindrical rootlets of *Stigmaria*, revealed by Mr. Butterworth's fine sections. They seem to have found their way into everything that presented the slightest trace of a penetrable opening or a cavity; and in one instance, one rootlet had forced its way into the interior of another in every respect, but size, like itself.

Ordinary Meeting, April 6th, 1869. E. W. Binney, F.R.S., F.G.S., Vice-President, in the chair.—Professor W. C. Williamson, F.R.S., gave an account of the present state of knowledge in reference to the structure of the gizzards and teeth of the Rotifera. After pointing out the discrepant accounts given by various writers on the subject, including his own examination of the teeth of Melicerta, he showed how all appeared to have failed in deciphering their anomalous appearances with perfect accuracy. He then directed attention to the very successful investigations made by the Rev. the Lord Sidney Godolphin Osborne, respecting the teeth of Rotifer vulgaris; and having not only studied with care his Lordship's preparations, but also compared them with his own examinations into the same animal, he was prepared to endorse the chief conclusions at which his Lordship had arrived: This dental organ consists primarily of two slightly arcuate jaws, broad at their upper extremities, and narrow and

pointed at their lower ones. Elastic ligaments bind these together at each end. The front or convex margin of each jaw is crenulated, the projections corresponding with the transverse parallel ridges usually regarded as the teeth of the animal. These jaws form the two lips of a sac, the lateral parts of which consist of a separate tissue, which overlaps each jaw at its anterior margin, hooked on, as it were, to the crenulations, and thrown by them into permanent parallel corrugations. Each of these corrugated organs passes first outwards and then downwards and backwards, where they are bound together by another broad membrane, which completes the sac posteriorly. The food enters this sac by a passage from the œsophagus, at its superior extremity, is crushed between the two jaws, and then passes out again by a similar orifice at its opposite or lower end to enter the stomach. Of these tissues the jaws are the hardest, and are capable of being dissected out, as Lord S. G. Osborne has succeeded in doing. The lateral corrugated organs have a concavo-convex form, which they appear capable of retaining after dissection; they appear less dense than the jaws, but more so than the membranous tissues of the gizzard, to which they are united. The central corrugations are always the largest.

Professor Williamson also called attention to the fact, originally noticed by Leeuwenhök and afterwards confirmed by Spallanzani and others, of the possibility of reviving these animals after protracted desiccation. He exhibited some small glass tanks of Rotiferous aquaria, some of which had been prepared by Lord S. G. Osborne, which had been dried up again and again. One of these, in a dry state, as it had been for five months, was moistened by the addition of a little water, and in five minutes the animals were in full activity, looking thin and hungry, but perfectly vigorous. The experiments of Lord S. G. Osborne confirm the statements of Spallanzani, that these Rotifers may be dried up for years without vitality being destroyed. Tanks for the preservation and examination of these objects are readily made by joining two ordinary microscopic glasses on three sides by means of electric cement, and then stocked by the introduction of a little Rotiferous dust. In such tanks they multiply rapidly, the occasional addition of a few drops of water to counteract evaporation being all that is needed for their preservation. The above communication was further illustrated by some beautiful models constructed by Lord S. G. Osborne, and kindly lent for the occasion.

Microscopical and Natural History Section.

March 1st, 1869. J. B. Dancer, F.R.A.S., President of the Section, in the chair.—Mr. Sidebotham exhibited moths he had bred from some of the cocoons from Natal, which had been sent to the Manchester Chamber of Commerce. The name of one of these moths is *Anaphe reticulata*, and it is described by Mr. Walker as a new genus and species. The characters were then given.

A nest of one of the mason spiders from St. Thomas was exhibited

by Mr. Sidebotham. Its form was that of an irregular tube, composed of clay and bits of stone, rather more than 3 inches long and 1½ inch in diameter; this is lined with fine silk. The cover is formed of similar clay and bits of stone, and has a very beautiful and durable hinge of silk fibres. When this nest is built in a hollow on the ground and the lid closed it would be next to impossible to detect it, and the lid fits so beautifully that no rain can penetrate, nor could an enemy without great difficulty open the lid from the outside.

Mr. Sidebotham also brought under the attention of the Section a specimen of rosewood from Brazil, showing the curious chambers made by one of the carpenter bees. These are on a much larger scale and more highly finished than those made by our English species.

Mr. Dancer exhibited an emperor moth, which had been found alive by Mr. W. Mellor, of the Ardwick Lime Works, in his house, on the 17th February last.

Mr. Dancer read a paper on the markings on the scales of *Lepisma*, and in *Pleurosigma angulatum*, which was reproduced in our Number for April. Mr. Walter Morris exhibited two slides of *Pediculus pubis*, which displayed the anatomy of these insects very beautifully. Mr. Hays made some observations describing a number of experiments on *Anguillula itritic*; and, finally, Mr. Spencer Bickham read a paper "On the Flora of Cheshire," with notices of the new and rarer plants of the country.

Brighton and Sussex Natural History Society.*

April 8th, the President, Mr. Glaisyer, in the chair.—An evening for specimens. The only microscopic object exhibited was a hemipterous insect, *Tingis hystricellus*, new to science, from the Island of Ceylon, where it was discovered by Mr. Staniforth Green on the underside of the leaves of a plant the native name of which is Bringall, and by that gentleman sent to Mr. Curteis, of Holborn. Under the microscope it presents the appearance of an insect porcupine, the head, thorax, and elytra being covered with a complete armature of spines, each of which is terminated by a seta, which seems to project from an open sheath. This insect was shown by Mr. Wonfor under one of Beck and Beck's Popular Microscopes, fitted with their new glass stage which affords a very smooth and delicate movement, admitting, as was shown, of an object being found with the greatest facility even under high powers.

The Chicago [U.S.] Microscopical Club.

The Chicago Microscopical Club held an adjourned meeting lately, at Rush Medical College, by invitation of Prof. J. W. Freer, M.D., to witness his exposition of the anatomy of the blood cells.

At the regular meeting of the Club, held at the Academy of

* Report supplied by Mr. T. W. Wonfor.

Sciences, January 26, W. W. Allport, D.D.S., was elected President; James Hankey, Vice-President; Henry F. Munroe, Esq., Treasurer.

In stating the object of the meeting, the President said that the existence of a nucleus in blood corpuscles has been long a question with histologists. Such distinguished men as Drs. Carpenter, Dalton, Peasley, Wharton Jones, Kölliker, Bennett, Beale, and McDonald, have denied their existence. Virchow is the only author who has strongly inclined to the opinion of their existence, and he simply assumes the fact without clearly demonstrating it. Within the last twelvemonths Prof. Freer has discovered in these corpuscles characters which have never before been mentioned by any author on human histology. In his recent visit to Europe, he exhibited their structure to Prof. Hughes Bennett, of Edinburgh, who subsequently stated to a physician of Chicago, that Prof. Freer had presented to him characters in the blood cells which he had never before witnessed. Other prominent European histologists made the same frank acknowledgment. If what Dr. Freer should exhibit shall prove to be the real nuclei of the blood cells, it will be sufficient to hand his name down in the history of medicine as the discoverer of what has long been sought, but never before found.

Prof. Freer, in presenting the subject of the evening, said that histologists acknowledge the existence of a nucleus in the reptilian blood-cells. He had always believed the blood cells of warm-blooded animals nucleated also. When viewed by transmitted light the structure is lost, and it is only when shown by reflected light as an opaque object—which he was able to do by the use of an illuminator, invented and patented by Prof. H. L. Smith, of Geneva, N.Y.—that the anatomical structure of the cell is truly exhibited. This shows the cell as a bi-concave disc, with the nucleus appearing as a prominence in the centre. He did not make this as a positive assertion, but exhibited the object, and left scientific men to draw their own inferences.

Dr. S. J. Jones stated that he saw Prof. Bennett subsequently to his meeting with Prof. Freer, and that Prof. Bennett expressed his high satisfaction with the presentation of the cells which Prof. Freer made.

The Club then proceeded to inspect the corpuscles, and, subsequently, other interesting preparations made by Dr. W. C. Hunt.

After a brief discussion of the points presented, and the adoption of a vote of thanks to Prof. Freer and Dr. Hunt for the gratification received, the Club adjourned.

Reading Microscopical Society.*

16th March, 1869.

Captain Lang, President, in the chair.—Mr. Collier read a paper (accompanied by extempore remarks) "On Polarized Light," dealing

* This Report was unavoidably "crushed out" of last number.—Ed. M. M. J.

with the two theories as to the nature of light, the phenomena of interference, differences between common and polarized light and polarizing apparatus generally. The paper was followed by a discussion.

Mr. Tatem furnished "Notes on a New Species of *Mallomonas*," differing from *Mallomonos Plösslii* in its much more elongated, almost naviculated form, proportionately shorter flagellum, much greater length of terminal hairs, and in uniformity of colour. He claimed for it the position of a new species, and proposed as its name, *Mallomonas elongatus*. Its specific characters were detailed, and the creature itself exhibited.

Mr. Tatem also brought for exhibition water containing vast numbers of the free swimming young (about $\frac{1}{1100}$ to $\frac{1}{1000}$ inch) of *Vasicola ciliata* (described and figured in No. 2 of the 'Monthly Microscopical Journal'), but from which the adult free and invaginated forms had almost wholly disappeared. He stated that though the young *Vasicola* had been known to him for years, he had failed to recognize it as other than *Megatricha integra*, and suggested the possibility of its having been described by Perty (in this early stage of its existence) under that name. He also expressed his belief that *Chætomonas globulus* would ultimately be found to be a still younger form of *Vasicola ciliata*.

Captain Lang exhibited slides illustrative of Mr. Collier's paper on polarized light; amongst others, spiral crystals of sulphate of copper, *Ballia brunonis*, and *Sphacelaria filicina*, the only two seaweeds he has found greatly affected by this method of illumination; and the lips of a Fly, attached to which was a star-like hair from the ivy-leaf, which would not have been detected under ordinary light, but was distinctly apparent under the Polarizer. He drew attention to Mr. Swift's form of achromatic condenser, which, in a very simple and effective manner, gives a dark ground to polariscopic illumination, producing a beautiful effect. Later in the evening he exhibited the proboscis of the blow-fly, showing the salivary ducts and lancet-like ligula, with its sheath *in situ*, but lifted from the chitinous pleat of the membrane in which it lies.

He also brought before the notice of the members Mr. Kent's cement, consisting of gum-damas dissolved in benzole, showing objects mounted in glycerine perfectly cemented and fixed by this material.

Mr. H. A. Simonds also exhibited several polariscopic objects.

April 20th, 1869.

There was but a small attendance of members.

Mr. Tatem contributed a paper "On Free-swimming Amorbæ," in which he described the characters and habits of two species; one of about $\frac{1}{1200}$ to $\frac{1}{1000}$, progressing with slow, oscillatory, and revolving motion; the other of about $\frac{1}{800}$ to $\frac{1}{500}$, having a flagellum, and swimming with slow, vacillating, and semi-rotatory motion. He also briefly discussed their relations to Amorbina generally.*

* Report supplied by Mr. B. J. Austin.

Bristol Microscopical Society.*

April 21st, 1869.

Mr. W. W. Stoddart, F.G.S., F.C.S., President, in the chair.—The minutes of the last meeting having been read and confirmed, the evening was spent in the examination of various objects exhibited by the members, in accordance with a resolution passed at the last meeting of the Society.

The following were the most interesting of the objects shown:—

By the President, Crystallized Silicon; by Mr. S. K. Swayne, Sections of adult and adolescent bone; by Mr. W. Lant Carpenter, Specimens of Eozoon and three forms of microspectroscope, showing the gradual improvements which had been effected in the construction of the instrument; by Mr. W. J. Fedden, Sections of *Alveolina elliptica* and *Lemna* (*Woolfia*) *arhiza;* by Mr. T. Isaac, *Melicerta ringens;* by Mr. Yabbicorn, Spinal vessels from the root of the Hyacinthe; by Mr. Tibbetts, Sections of Spinal Cord; by Mr. Leipner, Odontophores of seventy species of gasteropodous mollusks; by Mr. F. R. Martin, a series of fine transparent injections, and slides of Bisulphuret of Tin, Berberine, and a series of selected diatoms; by the Secretary, Section of the bill of *Platypus anatinus*, outer coating.

* Report furnished by the Secretary.

CORRESPONDENCE.

Woodward's Heliostat.

To the Editor of the 'Monthly Microscopical Journal.'

Washington, D.C., *March* 13, 1869.

Dear Sir,—In the January number of your Journal, page 29, is a short description of a cheap Heliostat for use in making photomicrographs, which is erroneously ascribed to me. I sent the account of it to Dr. Maddox, in May, 1868, with the request that he would publish it if he thought it of sufficient importance. I expressly stated in my letter that the instrument was devised by my friend and assistant, Dr. Edward Curtis, but Dr. Maddox seems inadvertently to have overlooked this passage.

The facts are, that this cheap Heliostat was originally planned by Mr. Lewis Rutherford, of New York, and the modifications described in the January number of your Journal were devised by Dr. Curtis, who drew up the description there published. I regret this misunderstanding the more, as in your February number, page 131, the instrument is also ascribed to me by Mr. Higgins. I sent him plans of the instrument in answer to an inquiry, making, however, no claims to its invention.

Will you kindly publish this note in your next number?

Very respectfully, your obedient servant,

(Signed) J. Woodward,
Assist. Surgeon and Bat. Lt.-Col.

Note.—We are also informed by Dr. Maddox, that the Photomicrographic Apparatus, figured in the Appendix of Dr. Beale's 'How to Work with the Microscope,' Plate lxix., 4th edition, and ascribed by him to Dr. Woodward, was devised by Dr. Ed. Curtis.

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THE

MONTHLY MICROSCOPICAL JOURNAL.

JUNE 1, 1869.

I.—*On the Proboscis of the Blow-fly.*

By W. T. Suffolk, F.R.M.S.

(*Read before the* Royal Microscopical Society, *April* 14, 1869.)

The structure of the Proboscis of the Blow-fly (*Musca vomitoria*, Linn.) having been discussed elsewhere * during the past year, I should not have brought the subject before the Royal Microscopical Society had there not been a want of figures in the papers already produced.

The earliest account I have been able to meet with is in an old German work on the microscope, by Cosmus Conrad Cuno, dated Augsburg, 1734. It contains two coarse representations—one a side view of the whole proboscis, the other a front view of the half-closed lips.

The next is an elaborate monograph by Gleichen on the common House-fly.† This work contains an exhaustive account of the insect's anatomy, illustrated with four well-executed coloured plates. The description and figures of the proboscis are wonderfully accurate, considering the imperfect instrumental appliances of the time. The figures relating to the proboscis are:—Plate XV., Fig. 29, a view of the head from below, showing the proboscis withdrawn and

DESCRIPTION OF PLATES.

Plate XIII.—Side view of Proboscis of Blow-fly, from preparation in glycerine.

" XIV.—View of Lips, showing general arrangement of Pseudo-tracheæ and parts about the mouth.

[Plate XV.

* Captain F. H. Lang, Reading Microscopical Society, 21st January and 17th November, 1868. B. T. Lowne, Quekett Microscopical Club, 27th November, 1868.

† Willhelm Friederich Freihern von Gleichen, 'Histoire de la Mouche Commune de nos Appartements.' Par l'Auteur des 'Nouvelles Découvertes dans le Règne Végétal.' Donnée au public par Jean Christopher Keller. Nuremberg, 1790.

folded up in its cavity; Plate XVI., Fig. 30, a side view of the head, with the proboscis exserted, both very good; and Plate XVI., Fig. 31, an inaccurate view of the back of the proboscis. It is most probable that the structure of the interior was unknown to this author, as the extension of the organ is attributed to inflation, and not to muscular action. The parts of the chitinous exo-skeleton named in my figures the Epiglottis and Mentum, are correctly represented, and named respectively the "upper and lower little scaly bone."

He also states that M. de Reaumur had discovered a sting, probably the ligula, the position of which is accurately described. With respect to the lips, the pseudo-tracheæ are represented in his figure merely as lines, and, by the description, were evidently taken for muscular bands. The milky fluid contained in the proboscis of a young fly is noticed, and also the copious flow of saliva. The function of the maxillary palpi is considered to be that of brushes for cleaning the proboscis.

PLATE XV.—Diagrams illustrating arrangement of the chitinous endo and exo skeleton:—

1. Side view, principally from specimen macerated in liquor potassæ.
2. Diagram of Ligula, Labium, &c. } From sketches supplied
3. Ideal section of lower joint of proboscis. } by Mr. B. T. Lowne.

a. Fulcrum (Pharynx).
b. Basal ring of Maxilla.
c, *c'*. Maxillary palpi.
d. Epiglottis (composed of labrum and terminal lobes of maxillæ united).
e. Labial palpi.
f. Ligula.
g. Chitinous process supporting tracheal or anterior surface of the lips (front view in Plate XIV.).
h. Labium.
i. Mentum.
k. Small chitinous piece protecting œsophagus.
l l'. Apodeme of mandible.
m. Lobe of Maxilla.
n. Chitinous processes serving as springs to close the lips.
o o'. Main channels of pseudo-tracheæ.

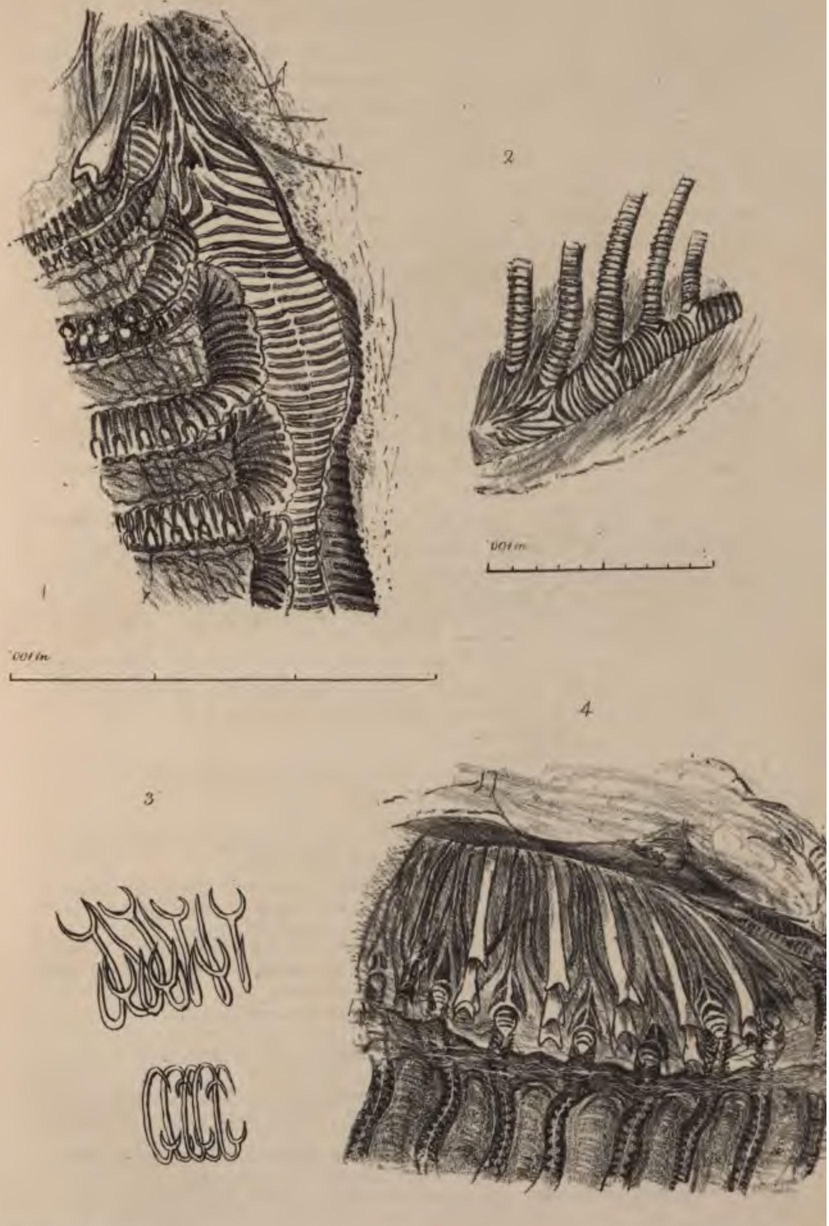
Note.—Two pairs of muscles are shown in the Plate as attached to the hooked processes of the Fulcrum (*a*) and the extremities of the chitinous rods *l* and *l'*; these only represent a very small portion of the muscular system, and not the whole, as might be inferred from the absence of others, and are figured to show the office of these portions of the skeleton.

PLATE XVI.—Fig. 1. One of the large main pseudo-tracheal channels, showing arrangement of the chitinous bands and the smaller pseudo-tracheæ joining the larger tube; on the left, at the top, are two of the teeth.

" 2. View of main channel and branches from the back, showing the arrangement of the chitinous bands at the junctions with main pseudo-trachea.

" 3. Hooks of chitinous bands of pseudo-tracheæ, after Mr. G. Hunt. 'Micro. Quarterly Journal,' 1856.

" 4. View of portion of the lips, showing triple row of teeth and mouths of pseudo-tracheæ; scale the same as Fig. 2.



W.T. Suffolk ad nat. lith.

Proboscis of the Blow-fly

Little or nothing appears to have been done until about the time of the improvement of the microscope by the introduction of the achromatic principle; and preparations in balsam, similar to those to be found in every cabinet, seemed to have furnished the authority for all the representations down to the present time. The lithograph by Mr. Leonard, after specimens prepared by Mr. Topping, is the earliest and the best of these. There is no date upon the plate; but it was probably published about twenty-five or thirty years ago. It has been followed by Dr. Carpenter in the various editions of 'The Microscope and its Revelations,' and by other writers. A somewhat similar but far less accurate figure is given by Mr. Samuelson.* There is also a woodcut by Mr. G. W. Ruffle, from the common preparation, in 'Science Gossip,' vol. ii., p. 83.

These figures call for very few remarks. They differ chiefly in quality of execution; being all more or less correct representations of the balsam-mounted and much-compressed proboscis so well known in every collection of objects. I have no fault to find with the preparation as a specimen of the mounter's skill. It is undoubtedly a great feat to reduce to an almost perfect plane an organ so thick and full of muscle, and having a complicated endo and exo skeleton of chitine. The object is one of singular beauty, is a valuable test for the performance of low-power objectives, and will probably always be one of the most saleable of preparations.

The late Richard Beck appears to have had his attention attracted by the imperfect state of our knowledge of the structure of the proboscis; and from what I could gather from a conversation with him, he had devoted much time to inquiries connected with the subject, especially to observations upon the living insect by the aid of reflected light and the binocular microscope, a course of proceeding strongly advocated and most successfully carried out by him, and to aid which he contrived many ingenious and extremely useful instrumental appliances. During the progress of the present inquiry I endeavoured to ascertain whether any of his valuable observations had been recorded; but the only document existing was a water-colour drawing of the half-closed lips, dated 12th July, 1862. A half-obliterated pencil sketch is on the margin, which appears to represent a section of one of the pseudo-tracheal tubes.

My own researches originated in an attempt to imitate the common preparation: considering glycerine a more eligible medium than Canada balsam, I endeavoured to mount a slide, and, finding a difficulty in flattening the proboscis, contented myself with allowing it to take its own position, which is represented in Plate XIII., and

* 'The Earthworm and the Common House-fly.' By James Samuelson and J. Braxton Hicks. 1858.

is drawn from this first preparation, mounted in September, 1865. Like most glycerine preparations, especially thick ones, it did not at first reveal all its beauties of detail, and was put aside as a failure. It was not until after a long time, nearly a year, that I considered the slide to be of any particular interest. I then found that many structural peculiarities which had escaped me in the usual preparation were distinctly shown.

In studying the structure of the proboscis, it is well to commence with the examination of a recently-killed insect. If chloroform is used as a means of death, the proboscis will almost invariably be found in an extended condition; and, by attaching the fly by means of gum to Beck's disc-holder, it can readily be placed in any position, and examined by reflected light. Very profitable use can also be made of an adaptation of Mr. S. J. MacIntire's cork cells,* in which a fly can be kept, and its manner of feeding watched, by careful management, with a 2-inch or 1½-inch objective. The colour and texture of the tissues of the proboscis are, however, singularly unfavourable for examination by reflected light; therefore if any knowledge of internal structure is required, it is necessary to resort to dissection or some mode of preparation. Most of my own specimens have been prepared by soaking the recently-killed flies in glycerine, and leaving them there until required for examination. They have usually been mounted in the same fluid in various positions, and such specimens show the muscles and chitinous endo and exo skeleton with considerable clearness. When, however, a good view of the skeleton is desired, a short boiling in caustic potash and mounting in a solution of chloride of calcium will give good results. I have usually avoided any undue compression in mounting the proboscis, excepting where it has been necessary to make a very thin preparation for observation with high powers. Mr. Ross's 4-inch objective has done good service in enabling flies to be conveniently watched in the large glass-topped boxes, which make admirable breeding-cages.

In describing my drawings, I can do little else than follow the papers of Mr. Lowne and Captain Lang, who with myself were, until recently, working apart and unknown to each other. The skeleton consists of a large, hollow, triangular piece (Plate XV., Fig. 1 *a*). The fulcrum, having two hooked processes at its posterior extremity serving as an attachment to two powerful extensor muscles (represented *in situ* in the same plate), as well as a complicated muscular system belonging to the posterior joint. Some of the muscles much lacerated are seen forced through the membranous envelope in Plate XIII., on the right-hand side, just above the maxillary palpi.†

* 'Journal of the Quekett Microscopical Club,' July, 1868, p. 69. 'Monthly Microscopical Journal,' April, 1869, p. 203.

† This figure has accidentally been drawn in an inverted position.

SIDE VIEW OF PROBOSCIS OF BLOW-FLY.

As this part of the skeleton projects considerably towards the front, the posterior two-thirds is cut off in the preparations commonly made for sale, as it offers an insuperable obstacle to the flattening process formerly in vogue. Connecting the fulcrum with the lower joint of the proboscis is the small irregular ring (*k*), for which I have at present no name. Attached to the exterior membrane on the front, are two chitinous processes, each bearing from six to eight long stiff hairs (*b*), and named the basal rings of the maxillæ. Near these will be found the two maxillary palpi (*c* and *c'*) (brushes of Gleichen); respecting the function of these I possess no information, never having in the course of my observations noticed that the fly makes any use of them. Connecting the upper and lower joints are two long chitinous rods (*l* and *l'*), having trumpet-shaped posterior extremities to which muscles are attached, and which play an important part in moving the lower joint. The skeleton of this joint consists of more pieces than that last described, and bears at its extremity the complicated lips. The most conspicuous piece is the mentum (*i*), which, like most parts of the external skeleton, is covered with stiff hairs arising for circular pits, this terminates anteriorly in a forked process (*n*), described by Mr. Lowne as a spring closing the lips when at rest, the function of this portion is to support and control the motions of the back of the lips. On the opposite side, or front, is the Epiglottis (*d*), partially enclosed in folds of membrane (Plate XV., Figs. 1 and 3 *d*), upon disengaging this by means of a needle there are seen within the ligula (Figs. 1 and 3 *f*), described by some as a tongue or lancet; and more in the interior the labium and labial palpi (Figs. 1, 2, 3 *h* and *e*), bearing at their extremity a forked piece (Plate XV., *g*), supporting the upper surface of the lips.

The lips I have endeavoured to represent in (Plate XIV.) the radiating tubes, which for want of a better name I must call Pseudo-tracheæ, are the portion of their structure which usually attract attention at first sight; and it is to their extreme beauty of arrangement and detail that the mounted slide owes its deserved popularity. The pseudo-tracheæ above and below the oral aperture are arranged in four groups, each connected with a larger tube, these four main tubes emptying themselves into the oral aperture; the ten central tubes on each side of the mouth open directly and independently, having disposed between them long forked appendages; the teeth (Plate XVI., Figs. 1 and 4), arranged in three rows, the back row of which perhaps are hardly to be considered as proper teeth, as they are attached rather closely to the membrane of the lips. The office of these teeth is undoubtedly that of cutting instruments or scrapers. I have examined carraway comfits after flies have fed upon them and found them covered with parallel scratches, the distance of which, when measured with the micrometer, cor-

responded exactly with that between the teeth; I have frequently used raw meat as food for my flies and have found it eaten freely, notwithstanding it has been dried up by being left for some time; they are also able to perforate hard sugar with the help of these and the copious supply of saliva with which the whole disc is supplied.

With a view to obtain more perfect specimens of grooved sugar I tried, among other materials, the gum paste of the confectioners, a mixture of white sugar, gum-tragacanth, and starch. This composition was greedily devoured by the flies, but instead of retaining the tool marks better, proved even more soluble than pure hard sugar. Probably sugar adulterated with plaster of Paris would prove a more suitable material for these experiments.

Respecting the teeth of *Musca domestica*, Captain Lang remarks "that there appears to be only one row, each tooth considerably broader than in *Musca vomitoria* and tridentate, and on either side of these principal teeth may be seen a very delicate one, so that there are the same number as in the Blow-fly, though differently arranged." I have not yet been able to confirm this statement by actual observation, owing to specimens not having been procurable. A comparison of the oral appendages of several species would no doubt elicit many facts of interest.

The skeleton of the pseudo-tracheæ consists of curiously forked half-hoops of chitine (Plate XVI., Fig. 3), correctly figured by Mr. G. Hunt;* each piece terminating in a single point at one extremity and a fork at the other, so arranged that the row presents an alternate series of forked and pointed ends; this supports a membrane which follows the zigzag line caused by the forked arrangement, each hollow being met by a corresponding projection on the opposite side, possibly giving the fly the power of accurately closing the slit on the upper side of the pseudo-tracheæ at will. I do not think this view at all inconsistent when it is considered what a very mobile organ the whole of the disc is—capable of adapting itself closely to the irregularities of any surface with which it may come in contact. In the larger main channels before mentioned the forked terminations (Plate XVI., Fig. 1) are wanting, and the chitinous semi-hoops are divided at the back, probably to give flexibility. The arrangement of the chitinous bands near the junctions of the various parts of the system is extremely curious, and devised so as to allow of the greatest possible amount of motion, consistent with the tube being kept open, being given to all the parts (Plate XVI., Fig. 2).

The pseudo-tracheæ apparently terminate in tapering ends. Whether this is their actual termination I have not been able to ascertain. Each pseudo-trachea is accompanied on each side by a

* 'Microscopical Quarterly Journal,' 1856, p. 238.

minute waved line represented in some portions of Plate XIV. and Plate XVI., Fig. 4; the appearance is one that I cannot interpret with any certainty.

The pseudo-tracheæ of the central portion of the lips which open between the teeth appear shortly after their commencement (Plate XVI., Fig. 4) to curve beneath a fibrous band surrounding the mouth, rising again to the surface just beyond, and continuing their course towards the margin of the disc. The chitinous semi-hoops at the oral end of the pseudo-tracheæ have not the alternate forked and pointed arrangement, but are simple, and alternately long and short, like those main channels (Plate XVI., Fig. 2); the pseudo-tracheæ which open into these channels have also the same simple arrangement of their skeleton where they join the larger channels.

The two lobes of the lips when in a state of rest are folded upon each other, when in use they may be in any condition between this and full extension; or even with the margins turned back and the teeth prominent, the whole organ is so flexible and continually in motion that it is almost impossible to make even a rough sketch during the life of the insect. The difficulty of observations upon the disc of the living fly is increased by the copious flow of saliva which, when the insect is under the influence of chloroform, flows over the surface of the lips, and speedily prevents any details from being seen.

With regard to the source of this flow of saliva, I quote at full length a communication received, with specimens, from Mr. J. G. Tatem, of Reading, remarking that about the same time the discovery of the function of the salivary duct, before considered by him as a tracheal tube, was made by Mr. Lowne.

"The salivary glands of the Blow-fly are long, much-contorted tubes, of nearly equal diameter throughout; unravelled, they would probably exceed by one-half the entire length of the insect. Attached to either side of the œsophagus within the thorax they are closely bound to it by tracheal ramifications in two little bundles. The tubes become membranous, though more condensed and transparent as they pass through the cephalo-thoracic constriction into the head, where they send forward their ducts, which at the base of the proboscis unite to form a common duct extending to the chitinous tubular root of the so-called "lancet," or, as I am disposed to consider it, tongue. The ducts are, as usual, held open by a spiral filament of greater tenuity than that of the tracheæ. Two flattened, ribbon-like nerves given off by the sub-œsophagal ganglion accompany the ducts throughout their entire course, and terminate at the tubular base of the tongue; probably ramifications too minute for my detection spread to the lips and adjacent parts."

I consider the pseudo-tracheæ as channels for the conveyance of fluid; the disc itself I regard as a very perfect sucker. It is evident that unless some provision were made by means of these pseudo-tracheal channels, either the adhesive power of the surface of the disc would be impaired, or else the passage of fluid nutriment from the margin of the disc to the centre would be stopped; the open gutters allow of a perfectly free passage for fluids, while the membranous interspaces act as suckers. My observations upon the living fly feeding upon syrup dried on the cover of a live-box have not been very successful, the view being obscured as soon as the clear surface of the sugar was roughened by the action of the lips, the only fact established being that the lips are capable of being closely applied to the surface with which they may be in contact; the state of the pseudo-tracheæ whether the slits are open or closed, and the action of the teeth and parts about the mouth, is still unknown to me, so far as actual observations of the surface of the disc are concerned. I have learned far more from watching a fly feeding in a cell.

During the preparation of the present paper I have received much valuable information and assistance from Captain Lang and Mr. Tatem, of Reading, who have kindly placed their papers and specimens at my disposal; also from Mr. Lowne, to whom I am indebted for the names of the various parts of the skeleton, besides other help in observations connected with the subject. To these gentlemen I tender my thanks, and hope that I may have an opportunity of returning their kindness by assisting in their observations still in progress.

I cannot close this paper without calling attention to the great value of the binocular microscope for this class of observations; indeed, the introduction of the binocular principle, by revolutionizing the mode of preparation, and encouraging the examination of thick specimens, with other and better modes of illumination than the old way by transmitted light, has been one of the causes of the great progress recently made in low-power observations. It is true that most of the structures here described can be seen in the old preparations, and can be understood by any one who has investigated the subject, and examined living specimens, just as a very dilapidated fossil can be recognized and described by an expert palæontologist. Extreme compression is doubtless of service in many instances, but accurate views respecting the arrangement and position of parts are only to be formed by, in the first instance, examining objects as little removed as possible from their natural condition.

II.—*On the Construction of Object-glasses for the Microscope.*

By F. H. Wenham.

(*Continued from page* 299, *No. V.*)

On the Production of Flat Surfaces in Glass.

The most important tools required for this work are three circular cast-iron laps, about six inches in diameter, having a screwed boss at the back, similar to the face-chuck of a lathe. These must be first turned flat on their faces, and then scraped to a true surface, either from a standard planometer, as practised by engineers, or else the three may be scraped together till no error can be detected by their interchange. It would, perhaps, be out of place to give the details of this operation, which is described in most elementary works on mechanism. These planes, as left by the scraper, are not sufficiently smooth for the purpose required; they must, therefore, be ground together. One of the plates is screwed down on a stud fixed in the bench or vice, and a wooden knob is fitted into the other to serve as a handle; they are then rubbed together with fine emery and water, frequently interchanging the plates. It is a very difficult matter to bring these plates to an exact plane by grinding alone, and to keep them so during their continued employment. The test of their truth is, that after they are all wiped clean and dry and rubbed together, the three should present a mottled appearance, uniformly covering the whole of their surfaces. One cause of error is a natural tendency of the grinding-powder to collect unequally between them. This may be somewhat corrected by frequently wiping it away from the places known to be hollow; and the grinding together should be performed with as little powder as possible at a time, and the strokes so managed as to abrade the high parts only. Practical experience is the best guide for this; and a clever workman will soon learn in what way and direction to work his blocks of glass, &c., on the laps, with very little injury to their plane figure, or even for the purpose of correcting it. In consideration of the extreme accuracy required in the prisms for spectroscope and other purposes, no pains should be spared in maintaining the perfection of these laps.

If a number of discs of glass intended for small lenses are required to be ground and polished to a flat plane, they must be cemented to a "block"—this is frequently merely a piece of wood turned with a convenient knob at the back for handling; others use a metal plate. Wood is handy for its lightness, but is liable to warp during the polishing operation, and so shift the discs;

to obviate this, I screw a flat piece of slate to the face of the wooden block, with a few common wood-screws.

The cement used for the glasses is either pitch hardened with some shellac, or common black sealing-wax. For a small series of discs, a block of about two inches in diameter will be found most manageable. The pieces of glass cemented on to this are arranged symmetrically, leaving as little interval between them as possible. They are now roughed down on the zinc plate till they are all brought to one level; they are then washed with a nail-brush and well rinsed, and fine ground on one of the laps, and next smoothed on a circular piece of cast iron but little exceeding the diameter of the block of discs. This smaller lap must be carefully ground to a true plane on the larger ones. A little of the finest washed emery and water is spread over this lap with a feather, and the glasses worked upon it in every direction, holding the lap in one hand and the block in the other, and occasionally turning both: this is continued till the emery begins to get dry, the glasses are then washed and wiped dry, and the smoothing proceeded with; but no more water must be applied to the lap. This is now moistened by simply breathing on it. In a few minutes the lap will again become dry; remove the block and wipe all the emery away about three-eighths of an inch from round the circumference of the lap; breathe on it again; continue the smoothing, and also wipe the emery away from the outside till, finally, scarcely any is left, and the glass is nearly finished on the metal itself. If this operation is properly conducted, the glass will have a transparent surface free from scratches and greys, and so near a polish that a few minutes only on the polishing lap will be required. But one rule must be strictly adhered to, *viz. never to polish a glass surface with any scratches in it.* It is worth while to spend any amount of time in smoothing rather than do this, and the operation must be repeated again and again, till no scratch whatever can be discovered. It is quite evident that to obliterate a scratch by polishing, the whole surface must be worked away till the bottom of it is reached. This makes the operation long and very tedious, and is almost certain to injure the perfectly flat plane which has been obtained by careful smoothing.

It is a difficult and hazardous task to polish glass on hard metal, as the surface is very liable to tear up. Consequently, the usual system is to employ a soft and partly yielding material, in which the particles of polishing powder may be imbedded. For facing the lap, I employ bees-wax hardened with resin, and stir some finely-washed ochre into the melted mixture. The lap itself is simply a brass plate, about three inches in diameter, which screws on to the lathe mandril; some of the above material is poured on to this, and spread into a layer of about one-sixteenth of an inch thick.

When cold it is turned off flat, and, to make it perfectly true, the whole face is scraped off at once with a hardened steel cutting straight-edge. An old parallel cotter-file will answer the purpose, ground from both sides like a blunt knife, and finally corrected on one of the cast-iron laps with emery. A series of shallow grooves, about an eighth of an inch asunder, are now turned in the wax, and some cross scratches made radiating from the centre, from which a piece should be taken out. The polishing powder, consisting of a mixture of crocus and putty powder before described, should be mixed in a small gallipot with plenty of water, and applied to the lap with a feather. The lathe is now run at a pretty quick speed, and the block of glasses worked over it in every direction with considerable pressure. If the smoothing has been properly done as directed, a few minutes will suffice to give the requisite polish, which is seen to take place equally all over the glasses; but if any scratches should develop themselves, it is better to repeat the smoothing than attempt to polish them out. This same method is employed if the glass were one continuous plane instead of numerous pieces.

For minute prism work, where the size is required to be only just sufficient to transmit or reflect the pencils from a microscope object-glass, and the surface has to be perfect up to a sharp edge, a somewhat different practice must be adopted; for however carefully the smoothing or polishing may be performed, a rounding of the extreme edge always occurs. To obviate this the edges must be guarded, as in the following examples. A, Fig. 1, is a prism to

Fig. 1.

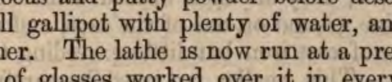
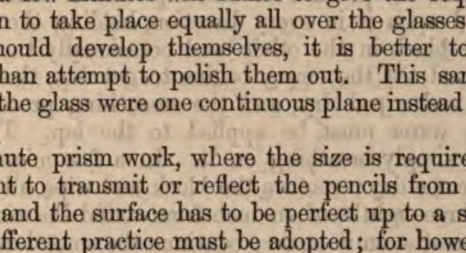


Fig. 2.



be worked to a very acute angle. A piece of glass large enough for the purpose, having one side polished, is cemented with Canada balsam to a parallel plate of glass, B; they are then ground off

together to the required angle and polished; the marginal error will be taken up by the lower end of the under-plate. It would be impossible to make an acute wedge of this figure in any other way, and when separated it will be found to have a knife-edge perfect at the extreme.

Another example may be described, from my practice in making the first prisms for the binocular microscope. A, Fig. 2, is an end view of the intended prism; this is supposed to have been a block of glass of larger size, with one polished surface cemented with Canada balsam on to the guard-plate, B; the front and back reflecting surfaces are then smoothed and polished; these are then covered with guard-plates, and the top emergent surface of the prism ground off and polished to the dotted line, C, C. It will thus be seen that every corner of the prism is protected during the working, and is kept absolutely perfect to the edge. The prisms were made sufficiently long to be cross cut into three or four. The smoothing was performed in accordance with the foregoing directions, but the polishing lap was required to be much smaller. The one that I employed was only $1\frac{1}{2}$ inch in diameter. If a large lap is used, the polish is apt to commence on the margins of the glass; and if this is the case a true reflecting figure will never be obtained. The polish should begin in the centre and spread to the outside. The proper angles for these prisms were set off by a graduated steel sector, and as the measurements have to be taken from the back of the guard-plates it is necessary that these should be exactly parallel; if not so, they must be ground on the surface-laps till all the edges gauge alike.

I may here remark that I am merely recording what has been my own self-acquired practice, and which is perhaps neither the most expeditious or easy. My best apology must be that I have always secured perfectly accurate results by these methods, and when a few only are required I must confess that I do not see a better way. But the great demand that has arisen for binocular prisms has induced the makers to discover a plan of working them in blocks, a number at a time, the particulars of which I do not pretend to explain.

Some very excellent prism work is produced on the Continent, and as the mode of polishing is peculiar it may be worth while to record it. Chevalier and Co., of Paris, through Messrs. Beck, politely sent me an explanation of the process, together with a sample of all the grinding and polishing materials used in their business. After the surface of the prism is smoothed, a piece of very thin, smooth paper (much resembling photographic negative paper) is cemented by its extreme ends with a little gum or dextrine *to the metal* lap; a lump of yellow tripoli (labelled "Tripoli de *Venise*") is then rubbed dry over the paper, and the prism, also dry,

polished thereon by hand movement; generally not more than two or three applications of the powder are required. I have tried this method with the identical paper and polishing material, but must state that in my hands the result has not been satisfactory for accuracy, at least in very small prisms; for larger ones it may answer better.

(*To be continued.*)

III.—*A New Universal Mounting and Dissecting Microscope.* By W. P. Marshall, President of the Birmingham Natural History and Microscopical Society.

This instrument consists of a convenient arrangement of dissecting microscope, combined with a complete set of apparatus for mounting microscopic objects, and a compound body is added, forming a student's microscope for general use; the whole being contained in a compact portable case, which when set open exposes all the contents conveniently for access. The object in the design has been to supply a want that has been felt, of a mounting apparatus containing in a *single small case* everything that is ordinarily required both in the examination and the preparation for mounting of microscopic objects; and thus affording the means of readily and conveniently securing upon the spot any objects found in the country or at the seaside, that would be deteriorated in microscopic value or lost altogether if their mounting had to be deferred until returning home. The whole apparatus is also very convenient and complete for mounting work at home.

The microscope has three simple lenses magnifying separately or in combination from 6 to 20 diameters, and a dividing objective of 45 and 90 diameters, with the means of adding any higher objectives from another microscope, the nose being made with the standard screw, and space allowed in the case for packing other objectives. The mounting apparatus includes a turn-table, hot-plate with spirit-lamp and dissecting-trough, with forceps, dissecting-knife, needles, dipping-tubes, &c., and a stock of mounting materials in fifteen bottles, with glass-slides and cover-glasses, &c. The whole is fitted into a compact case about seven inches cube, and arranged so that all the contents are at once accessible for use, and quickly repacked.

The microscope-stand is fitted with rack adjustment for focussing mirror, side-condenser, and stage-forceps; and when fitted with the compound body the stand has a movement into an inclined position.

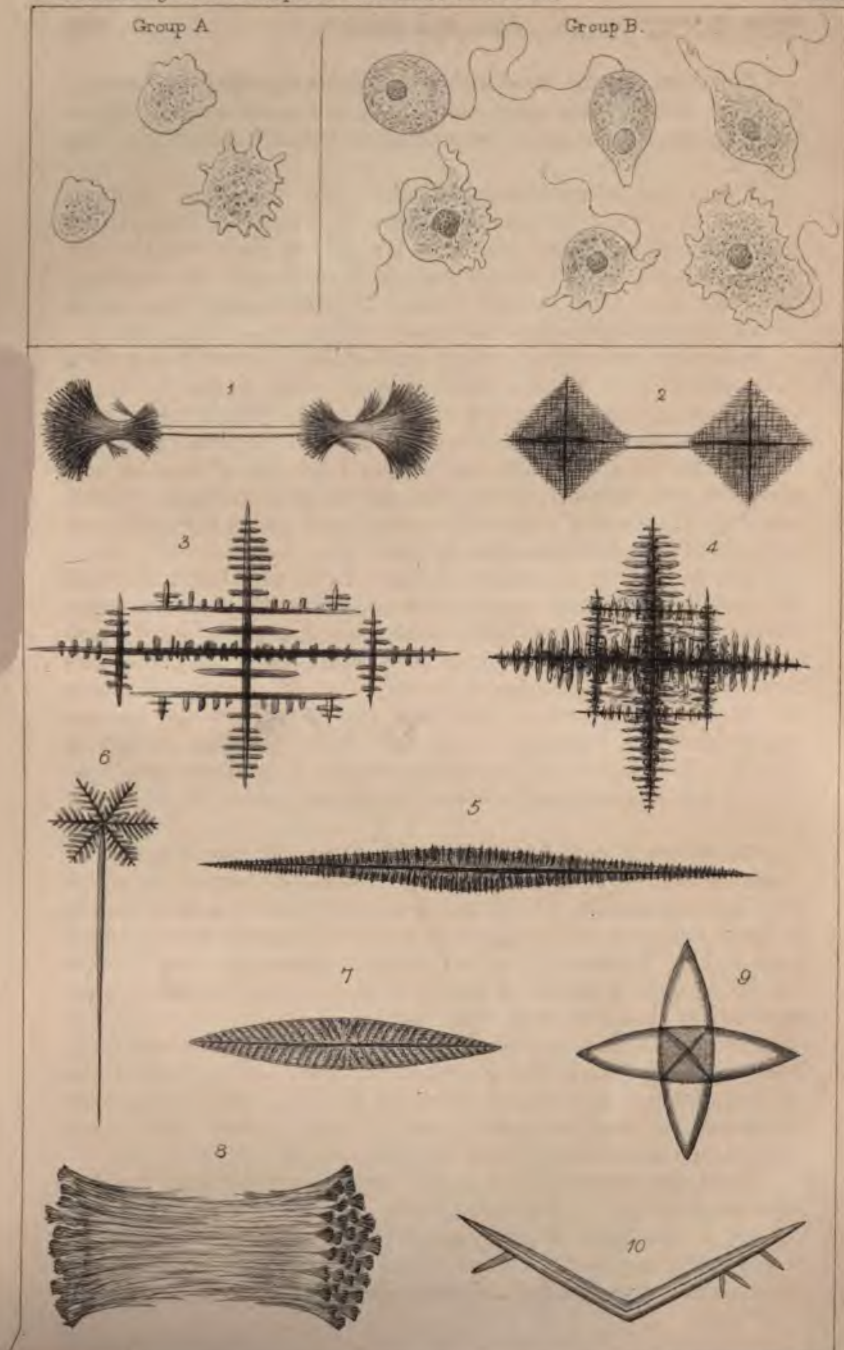
In preparing the specimens, so much of the substance must be added to the borax that it entirely dissolves at a high temperature, but is partially deposited when kept for some time at a heat below dull redness. The beads should be about $\frac{1}{8}$th inch in diameter, and $\frac{1}{3}$rd that thickness. The loop in the platinum-wire can easily be made circular by bending it round a glass rod.

I need scarcely say that no one ought to expect to obtain good specimens at first. Much depends on that sort of manipulation which is easier to learn by experience than explain by writing.

The most useful object-glass is a $\frac{4}{10}$-inch, of small aperture, made to adjust for looking through thick glass, so that crystals may be distinctly seen in the interior of the beads. When no condenser is used, the double convex form of the beads prevents our seeing more than a small portion of the interior; but by using as a condenser a plano-convex lens, of about $\frac{1}{2}$ inch diameter and $\frac{1}{2}$ inch focal length, nearly the whole bead is well illuminated, without the definition being materially injured; and even this may be overcome by properly regulating the distance of the condenser and the size of the aperture below it. The full beauty of the specimens can only be seen with a binocular microscope, and few objects are better fitted to show the advantage of that kind of instrument. The crystals then stand out in perfect relief, and are seen to be equally complicated in all directions; but I have selected as illustrations those which lay flat, for the sake of simplicity. It must not be thought that in each case all the crystals are alike. Those formed on the surface differ much from those in the interior of the beads; and in both positions, though the type is constant, the forms vary very considerably.

After having obtained crystals of satisfactory character, if it be desirable to keep the specimen as a permanent object, the ring-shaped loop and enclosed bead should be cut off and mounted in a cell with Canada balsam. This is requisite, since the moisture of the atmosphere causes the borax to become hydrated and opaque; but, when properly mounted in balsam, it alters so slowly that I have not remarked any change after half a year. When thus mounted, the curved form of the beads almost ceases to be any impediment in examining crystals in the interior, and an ordinary achromatic condenser of long focal length may be used with advantage; but in some cases crystals on the surface are much less distinct than when the beads are not mounted.

Few objects of the kind are more easily prepared than the crystals of borate of magnesia deposited from borax saturated with magnesia. They first form as thin prisms, and smaller crystals are afterwards deposited, so as to give rise to objects very much like a handle with a brush at each end, as shown by Fig. 1.



W. West, imp.

Crystals in Blow-pipe beads.

Zircon or zirconia fused with borax yields crystals of the borate. In their most rudimentary state they are small prisms with a simple cross at each end, which afterwards becomes complicated like Fig. 2.

The crystals of molybdate of zirconia (Fig. 3), formed by fusing zirconia in borax with molybdic acid, are extremely elegant and beautiful objects. They are so delicate that their own weight would probably break them, if they were in an aqueous solution; but being supported in solid borax, like the insects enclosed in amber, they are secure from all injury.

Scheelite—native tungstate of lime—fused in borax is deposited in crystals of great beauty, and is an object easily prepared. Fig. 4 is a case where the axis of the crystal is in the line of vision. In the opposite direction the arms of the cross are unequal.

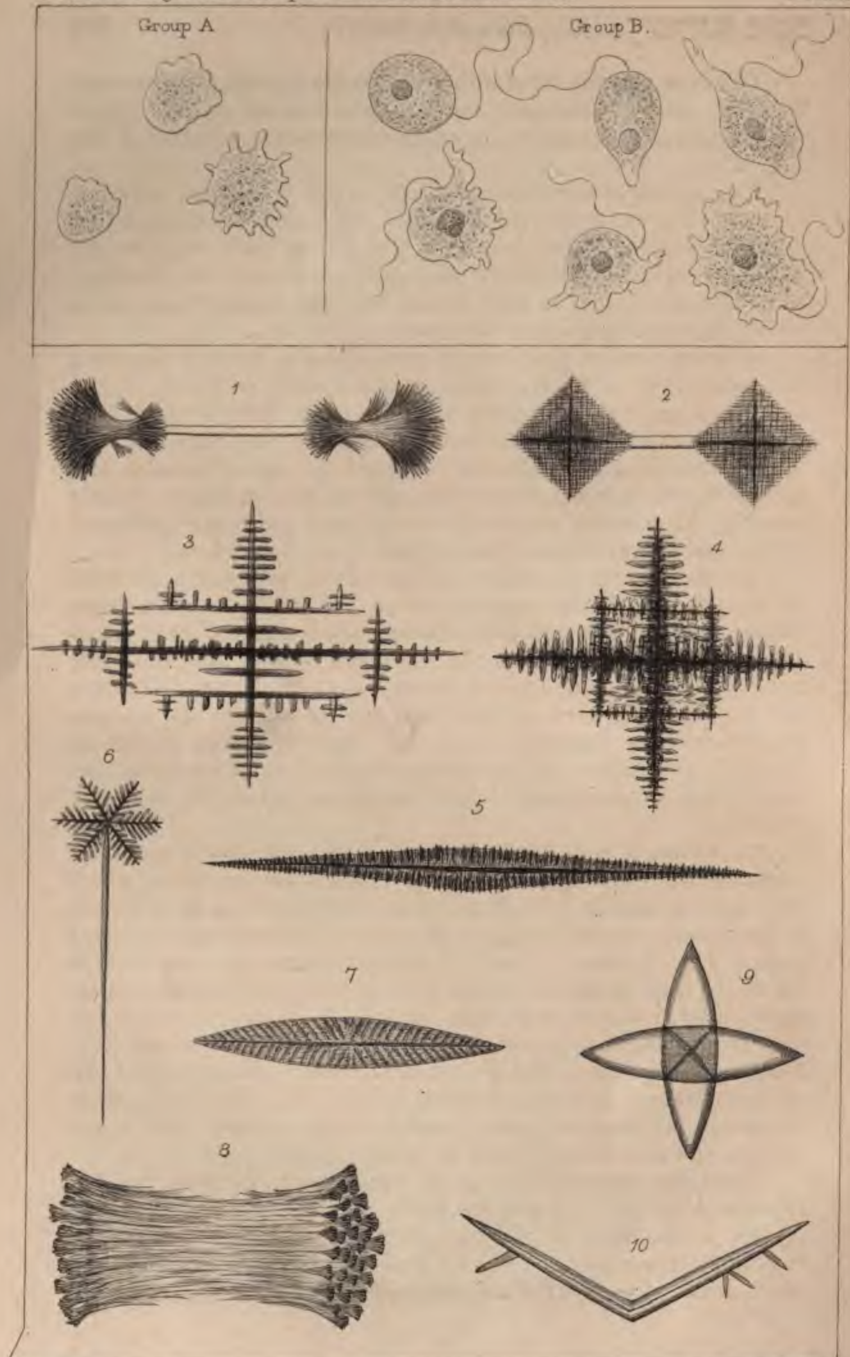
The molybdate of strontia, produced by fusing strontia and molybdic acid in borax, crystallizes in long spindle-shaped crystals like Fig. 5; whereas the molybdate of lime yields very different crystals, of a form intermediate between Figs. 3 and 4.

Apatite—native phosphate of lime—fused with borax, deposits in crystals which vary much in shape. Six-sided stars are often formed on the surface, and needle-shaped crystals grow from their centres into the interior of the borax, so that they look like nails with highly ornamented heads (Fig. 6) driven down into the bead. When formed with their axis parallel to the surface, the crystals are sometimes much like *diatomaceæ*, as shown by Fig. 7. The addition of phosphate of soda to a borax bead containing lime in almost any state of combination gives rise to similar crystals.

On adding a certain amount of carbonate of soda to quartz or various silicates dissolved in borax, crystals are deposited, which vary much according to circumstances; but they all seem to be due to the variable growth of many small six-sided prisms with expanded ends. Fig. 8 shows a curious dice-box form, resulting from a bundle of such crystals. Probably they are some silicate of soda, modified by the presence of other bases.

Columbic acid is deposited from borax in crystals which often have a form similar to Fig. 9; whereas titanic acid gives hair-like prisms variously grouped, as shown by Fig. 10. Molybdic acid is sometimes set free as liquid globules, which coalesce, rise to the surface, and afterwards solidify as small spheres.

These few examples will at all events serve to show that the crystals deposited in blow-pipe beads are of considerable interest, merely as beautiful microscopical objects. I should, however, be very sorry if any one were to imagine that I considered this their chief merit. On another occasion my aim will be to prove that



Tuffen West, sc. W.West imp.

Amœbæ ——— Crystals in Blow-pipe beads.

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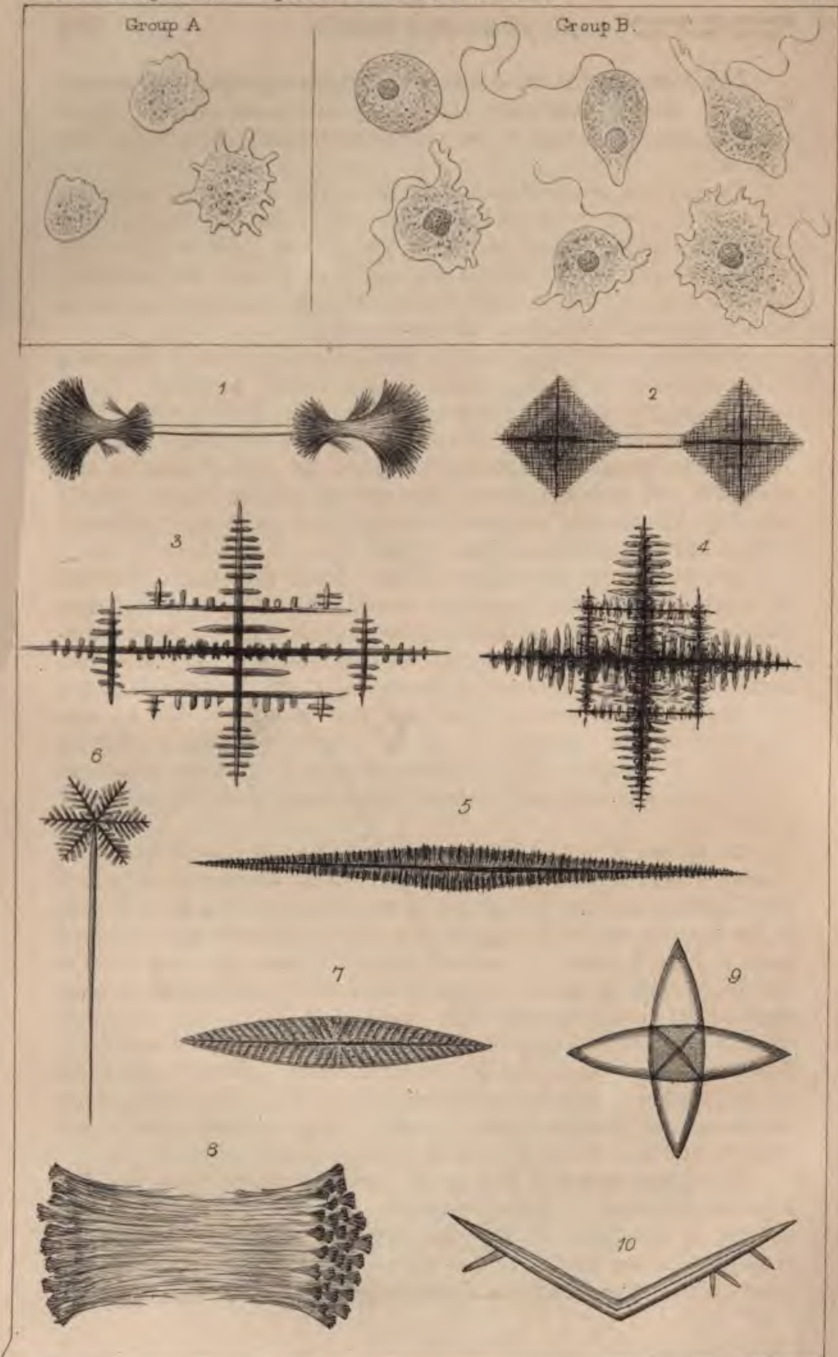

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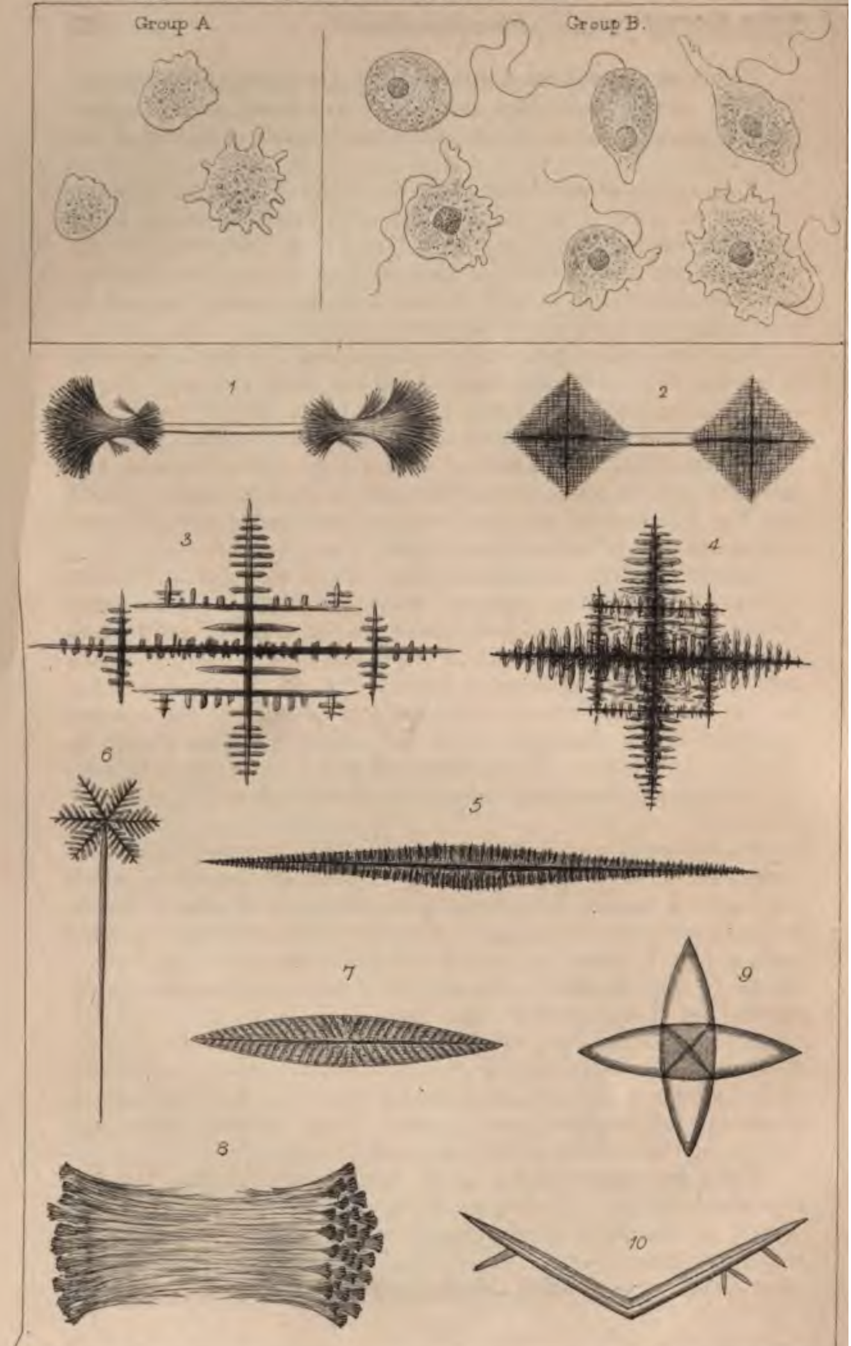
On adding a certain amount of carbonate of soda to quartz or various silicates dissolved in borax, crystals are deposited, which vary much according to circumstances; but they all seem to be due to the variable growth of many small six-sided prisms with expanded ends. Fig. 8 shows a curious dice-box form, resulting from a bundle of such crystals. Probably they are some silicate of soda, modified by the presence of other bases.

Columbic acid is deposited from borax in crystals which often have a form similar to Fig. 9; whereas titanic acid gives hair-like prisms variously grouped, as shown by Fig. 10. Molybdic acid is sometimes set free as liquid globules, which coalesce, rise to the surface, and afterwards solidify as small spheres.

These few examples will at all events serve to show that the crystals deposited in blow-pipe beads are of considerable interest, merely as beautiful microscopical objects. I should, however, be very sorry if any one were to imagine that I considered this their chief merit. On another occasion my aim will be to prove that



Tuffen West, sc. W.West imp.

Amœbæ —— Crystals in Blow-pipe beads.

Zircon or zirconia fused with borax yields crystals of the borate. In their most rudimentary state they are small prisms with a simple cross at each end, which afterwards becomes complicated like Fig. 2.

The crystals of molybdate of zirconia (Fig. 3), formed by fusing zirconia in borax with molybdic acid, are extremely elegant and beautiful objects. They are so delicate that their own weight would probably break them, if they were in an aqueous solution; but being supported in solid borax, like the insects enclosed in amber, they are secure from all injury.

Scheelite—native tungstate of lime—fused in borax is deposited in crystals of great beauty, and is an object easily prepared. Fig. 4 is a case where the axis of the crystal is in the line of vision. In the opposite direction the arms of the cross are unequal.

The molybdate of strontia, produced by fusing strontia and molybdic acid in borax, crystallizes in long spindle-shaped crystals like Fig. 5; whereas the molybdate of lime yields very different crystals, of a form intermediate between Figs. 3 and 4.

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this method may be employed with great advantage in determining the nature of minerals and chemical precipitates, when so small a quantity can be procured that other methods would almost or entirely fail to give satisfactory results.

V.—*On Free-swimming Amœbæ.* By J. G. Tatem, Esq.

Plate XVII. (upper portion).

In the late autumn of last year, in some water which had been long kept, I noticed many small, transparent, gelatinous-looking atoms of about $\frac{1}{1200}$ to $\frac{1}{1000}$, containing numerous relatively large greyish granules, progressing with a slow, oscillatory and revolving motion, preserving a more or less oval, though neither regular or permanent outline. Unable, with the magnifying power at command, to detect either the means of locomotion (though, from an uncertain flicker at the more rounded anterior extremity, a flagellum was believed to exist), or any notable structure, more perplexing creatures could scarcely have presented themselves. Accident, however, disclosed their true nature. An Oxytricha coming into violent collision with one of them, arrested its progress; pseudopoda were instantly thrown out from the margin of contact, in a few moments withdrawn, its former shape resumed, and course pursued. Patiently following it in all its movements, I had the satisfaction, after a long interval, to see it ultimately settle down, flatten out, protrude on all sides short round pointed pseudopoda in a radiary manner, and assume in all respects a true reptant *Amœba* form. In Group A, I have endeavoured to give a correct representation of some of the forms in both its free swimming and creeping conditions. Many subsequent observations, as well as those obligingly made for me by my friend Mr. Clayton, confirmed these facts, with the additional one, however, that alternations from the free to the reptant states were not infrequent. It should be noted that *Amœbæ* of several recognized species abounded in this water, *Amœba princeps*, *A. limax*, *A. diffluens*, *A. guttula*, and *A. porrecta*.

More recently another and distinct species has been under observation; larger, about $\frac{1}{800}$ to $\frac{1}{500}$, globular or ovoid, of a ruddy brown colour, with a very fine long undulating flagellum, swimming with a slow, vacillating, semi-rotary motion, passing from time to time into the reptant stage, as a filmy *Amœba*, with variable, mostly broad, laciniated pseudopoda—the flagellum re-

maining unretracted. A large reddish granular nucleus is noticeable in every specimen. Group B gives faithful representations of some of the forms assumed in passing from the free-swimming into the reptant stage. *Amœba villosa* abounded in this water, to the exclusion almost of every other known species.

Mr. Carter, in the 'Annals and Mag. Nat. Hist.,' describes and figures (vol. xiii., p. 21, plate 2, 1864), from a single specimen taken in a tank at Bombay, under the name of *Amœba monociliata* a species possessing a flagellum, a posterior villous patch, and reptant locomotion only. Neither of the two *Amœba* forms under notice can therefore be identified as Mr. Carter's *Amœba monociliata*. They must be regarded as either new and distinct species, or, and I strongly incline to the opinion, as phases of *Amœba* life. At present we have no other certain knowledge of *Amœba* propagation and reproduction than that by fission. An over-extended pseudopodum, perhaps larger than common, remains attached to the spot, to which it has been projected, separates from the parent mass, and creeps off as an independent living creature. That this summary and somewhat rude process may, under favourable conditions, go on with extreme rapidity, as we see it does in the more highly developed forms of ciliated Infusoria, I am neither prepared to admit or deny. Let this be as it may, it could only account for the presence of a vast number of individuals within a limited space, not for their dispersion through a wide area. Is it, therefore, more unreasonable, or opposed to analogy, to infer that the low-vitalized and slow-creeping *Amœba* should propagate its race and secure its general distribution by locomotive gemmules possessing but a single and feeble flagellum, than that the fixed and scarcely more organized sponge should gain the same end by means of its ciliated and more active gemmules? That we may not irrationally look for some such mode of reproduction as the result of conjugation, I am fully persuaded. That conjugation does take place is yet, however, open to doubt and disputation; but I can scarcely question that those unusually large *Amœbæ* we so frequently meet with in the autumn months, are actually the incorporation of two individuals in a copulative act; and such view is further strengthened by what we so constantly witness among those shelled Amœbæ—the *Difflugiæ*.

There is yet another view which may be taken as to the phase of life—if such it be—which these free-swimming *Amœbæ* present. They may be the adult form—the perfected animal. We have seen that after slowly labouring for a time through the water, they settle down, throw out pseudopoda, by-and-by withdrawing them, reassume the rounded form, and again struggle onwards. It is possible (though nothing has been observed in confirmation) that a pseudopodum detached while in its reptant stage, becomes an inde-

pendent living animal, which through repeated fissions gives origin to an infinite number of ordinary reptant *Amœbæ;* while the freely motile parent, pursuing its course, may from time to time, in the same manner, plant in congenial localities other such founders of populous colonies.

Such speculations as these, vain and futile as they must necessarily be, in the absence of direct observation to support them, may yet serve to direct attention, and to point out the road for further investigations; and whatever may be the results which attend them, one incontestable fact remains in our possession—that our pools and ditches afford more than one species of free-swimming *Amœbæ.*

VI.—*Action of Anæsthetics on the Blood Corpuscles.* By J. H. McQuillen, M.D., D.D.S., Professor of Physiology in Philadelphia Dental College.

In the October number of the 'Dental Cosmos' a report was presented of a series of experiments performed by me, on a number of animals, with the view of ascertaining whether the assertion made by a distinguished experimentalist and scientist of England, that nitrous oxide, even under the most delicate manipulation, would prove destructive to life, could be possible. These experiments, which clearly demonstrated the assertion to be unfounded, were not performed in private, but in the presence of a number of gentlemen whose experience in the use of anæsthetics, and whose scientific knowledge made them competent judges. First performed before the members of the Odontographic Society of Pennsylvania, they were repeated, after an interval of three weeks, on the same animals, in the presence of the members of the Biological and Microscopical Department of the Academy of Natural Sciences.

A month subsequent to the last-named occasion one of *these animals,* a rabbit, in the presence of a number of gentlemen, was placed under the influence of nitrous oxide, and kept in a profound state of narcosis for *one hour and five minutes,* by alternating atmospheric air and nitrous oxide, removing the inhaler ever and anon for that purpose. Without question the animal could have been kept in the same condition double or treble the time without injury to it, for in a few minutes after removing the anæsthetic entirely the animal was restored to consciousness, and leaped from the table to the floor, and for a number of weeks after this ran about my premises in a healthy and lively condition, and no doubt would have been still alive had I not demonstrated on him before

the students of the Philadelphia Dental College the absorption of fats by the lacteals of the villi of the intestines, below the duct of the pancreas, and also the action of the heart and lungs; necessitating as this did opening into the abdomen and thorax, life of course became extinct.

When under the prolonged influence of nitrous oxide referred to, one of the blood-vessels of this animal was opened for the purpose of examining the blood corpuscles under the microscope, and ascertaining whether they had become disintegrated or any change had taken place in their form. On examination no perceptible difference was observable even after this lengthened exposure to the anæsthetic, when compared with the blood of another rabbit, which was not under its influence. This result induced me to examine into the statements made by Dr. Sansom, relative to the action of anæsthetics on the blood corpuscles in his highly interesting and able work on chloroform.*

Prior to giving a description of my experiments in this direction, it may be proper to briefly refer to the prevalent theories on the physiological action of anæsthetics, also to the experiments performed and conclusions arrived at by Dr. Sansom. The view generally entertained is that first suggested by Flourens, that these agents act directly upon the nerve centres, producing regular and progressive modifications in the functions of the brain and spinal axis, first affecting the cerebral hemisphere, then the power of co-ordination in the cerebellum, then the conduction of sensation and motion in the spinal cord, and lastly, if the agent is pushed so far as to decidedly impress the medulla oblongata, suspension of respiration and circulation.

Dr. John Snow, regarding this theory as an erroneous one, and recognizing ether, chloroform, and other anæsthetics, as non-supporters of combustion, advanced the theory that these agents interfering with the introduction of oxygen into the system, induced their effect by the suspension of oxygenation, he therefore asserted that "narcotism is suspended oxygenation." This view is embraced and strongly advocated by Dr. B. Ward Richardson (the friend, biographer, and editor of his work on 'Chloroform and other Anæsthetics'), and in England, apparently, is being very generally adopted by writers on this subject; Dr. Kidd, who has devoted much attention to the study of the action of chloroform, is, however, a prominent exception.

Dr. Sansom, accepting this theory, and knowing that nitrous oxide is not only an anæsthetic but a supporter of combustion, recognized the necessity of presenting something more conclusive in the support of the view, than had heretofore been offered. He

* 'Chloroform, its Actions and Administrations.' By Arthur Ernest Sansom, M.B., London. Lindsay & Blakiston, Philadelphia.

therefore, in a paper read before the Royal Medical and Chirurgical Society, in 1861, as the result of certain experiments performed on the blood corpuscles of man and animals out of the body, attributed the influence exerted by anæsthetics on the nervous system to their acting directly upon the blood corpuscles, by modifying their form and integrity, and indirectly upon the nervous system through this altered condition of the blood, by interfering with its oxygenation. In his work he describes a series of six experiments; placing on glass slides, under a quarter-inch object-glass, human and frog's blood, and subjecting them to the *direct contact* of alcohol, ether, and chloroform, which resulted quickly in the disintegration of the blood corpuscles, leaving nothing but their nuclei and débris of the walls of the corpuscles. From these experiments on blood *out of the body*, he states in the work referred to: "The effect therefore of these agents upon the blood is solution—destruction. At first there is a change induced in the cell itself and upon the nucleus (in the case of frog's blood). The globuline of the blood is acted upon as it were by a caustic. Finally the old corpuscle is destroyed and its colouring matter set free." * * * From the foregoing facts and other considerations, the author considers that certain conclusions in regard to the action of anæsthetics are warrantable. Anæsthetics are agents which when absorbed into the circulation exert an influence upon the blood. They are shown to have the power of altering its *physical character* and *physical properties*. By an action upon its constituent (proteinous) elements, they tend to alter and by a profounder action to destroy its organic molecules. Its physical perfection being interfered with, its function is held in abeyance, the changes which contribute to constitute perfect life are retarded. Narcosis ensues; and is due, not to the influence of a circulating poison, but to the influence of an altered blood. Further on he adds: "Narcotism (or to speak more particularly, chloroform narcotism) is due not to a special poison that 'mounts up to the brain,' but to an altered blood. Then 'narcotism is a suspended oxygenation.' Whatever produces to a certain extent insufficient aeration of the blood, produces narcosis; and whatever produces narcosis produces by some means or other imperfect aeration of the blood."

In drawing these conclusions, of an altered condition of the blood, from appearances presented by the blood *out of the body*, Dr. Sansom evidently leaves it to be inferred that somewhat if not exactly analogous results are produced on the corpuscles *in the body*, when human beings or animals are under the influence of anæsthetics by inhalation. After a patient, oft-repeated series of experiments performed by me during the past three months, not only on blood out of the body, but also in cases in which human beings and animals have been placed under the influence of ether,

chloroform, and nitrous oxide, and the blood drawn from them *prior* to and *after* the administration of these agents has been carefully *examined* and *compared*, the results obtained compel me to take very decided exceptions to such conclusions being justifiable in the premises.

First Series.—The experiments were as follows: In my examinations of the blood of man and animals, when ether and chloroform were brought in direct contact with it out of the body, under a fifth objective, the discharge of the nuclei and the disintegration of the corpuscles have invariably occurred, and in the frog leaving the field occupied by the nuclei, débris of disintegrated globuline and corpuscles, in which the change of form, size, and other characteristics were most striking.

Second Series.—On placing, however, two glass slides containing frog's blood over watch-crystals, one holding chloroform and the other ether, and covering them with glass finger-bowls for half an hour, thus exposing one to an atmosphere of ether and the other of chloroform, I found, on removing the bowls and permitting the bloody sides of the slides to remain downward, until all the ether and chloroform had evaporated, that no disintegration or marked change in the form of the corpuscles was observable under the microscope, on comparing them with the blood of a frog unaffected by an anæsthetic. This forcibly demonstrates the difference between exposure to *direct contact* and the *vapor* of chloroform, even out of the body.

Third Series.—Over and again, in the presence of a number of gentlemen, I have placed frogs under the influence of ether, chloroform, and nitrous oxide, and examined their blood corpuscles immediately after without finding any disintegration or change in the form of the corpuscle. In one instance, a frog was so completely narcotized by chloroform that it died; the thorax of the animal was opened, the lungs cut out, and the blood obtained directly from that organ, and even here, where, if the inference of an altered blood was correct, there should have been discharge of nuclei, disintegration, or *marked* change in the form of the corpuscle, nothing of the kind was evident. As already intimated, the experiments in this direction have been prosecuted on every available occasion within the past few months; and I have not confined myself to frogs, but, in the course of vivisections on a large number of animals (rabbits, dogs, cats, and pigeons), to illustrate my course of lectures on physiology this winter, when these animals have been placed under the influence of ether or chloroform, their blood has been examined and no change in the form of the corpuscle has been evident.

Fourth Series.—The examination of the blood of a number of human beings, drawn prior to and after having been under the

influence of ether, chloroform, or nitrous oxide, for the extraction of teeth, has yielded similar results.

The results of these investigations were recently presented to the members of the Microscopical and Biological Department of the Academy of Natural Sciences, illustrated by a large number of microscopical slides, and although some time has elapsed since the blood was placed on many of them, the corpuscles retain their form unchanged.

Presenting the statements for what they are worth, and desiring that others may either confirm or disprove them by experiments of their own, as carefully conducted and as frequently repeated, and not merely performing a few experiments and then drawing conclusions which they would not be warranted in doing, I would suggest to such that there are two modes of preparing blood for microscopical examination, each of which has been tried in my investigations. First plan—the blood, placed on a slide, is spread with a knife-blade thinly over the glass, then waving it backward and forward in the air, the blood is dried by evaporation, and can be covered with a thin glass slide, cemented, and kept for a considerable length of time without change. Second plan—a drop of blood is placed on the slide, a thin glass cover is brought in contact with the edge of the drop, and by capillary attraction, a stratum of blood is drawn under it. Although this answers for immediate examination, unless some menstruum is employed for the preservation of the blood, its characteristics become so completely changed in the process of coagulation that the specimens become useless. In pursuing these investigations, care must be exercised to prevent the *direct contact* of ether and chloroform with the blood corpuscles, as this makes the greatest possible difference.

In conclusion, although it is not my intention in this communication to engage in an extended inquiry relative to how anæsthetics produce these effects, it seems to me that the above experiments demonstrate that we are not warranted in denying that these agents act directly upon the nerve centres. All the phenomena, indeed, attendant upon their administration, the gradual exaltation of the cerebral functions followed by the progressive impairment and temporary suspension of the special senses, the loss of co-ordination on the part of the cerebellum, and when the agent is pushed too far, the arrest of respiration and circulation through the decided impression made upon the medulla oblongata, seem to favour this hypothesis, in contradistinction to the theory that anæsthesia is due to suspension of oxygenation.

In connection with this, I cannot refrain from saying, when taking into consideration the readiness with which fluids absorb gases, that undue prominence apparently has been given by physiologists to the blood corpuscles as *the* carriers of oxygen to the

tissues, and carbonic acid gas to the lungs, for it is reasonable *to infer that the liquor sanguinis is actively engaged in this operation.* After the most careful examination under the microscope, I have been unable to observe those modifications in the form of the corpuscles in venous and arterial blood, changing from biconvex to biconcave disks, and attributed to the absorption of the gases, of which so much is said in the books. That anæsthetics, when acting directly upon the nerve centres, may interfere with the oxygenation of the nervous mass, is possible, but it is to be viewed rather as an *effect* than as a *cause* of narcosis. Again, even admitting that such agents as chloroform and ether, by interfering with natural respiration and the oxygenation of the nervous mass, might possibly produce their result in that way, it is difficult to understand how this can be brought to bear upon an agent like nitrous oxide, which contains an excess of oxygen over atmospheric air. To those who may assert that nitrous oxide is a compound (and not a mixture like atmospheric air), and therefore incapable of decomposition and furnishing oxygen to the nervous mass, I would remind them of a law in chemistry, that when two compounds, the elements of which have a stronger affinity for each other than the compounds in which they exist, are brought in contact under favourable circumstances, a mutual decomposition occurs, and new compounds are formed in their place. It may be said that the conditions in the body are not favourable to such results; but who shall have the temerity to assert that, when recalling the incessant compositions and decompositions of a chemical character taking place in the body, fully recognized and admitted by those who insist most upon the controlling influence of vitality? It is a well-known fact, that nitrous oxide is a supporter of combustion, and that a lighted candle burns with increased brilliancy in it; here the combination of the nitrogen and oxygen in definite proportion is not so strong but that the carbon of the candle is able to seize upon the oxygen, and augment the size of the flame. The function of respiration consists in a mere interchange of gases, of the exhalation of carbonic acid gas and the introduction of oxygen; the latter, absorbed by the blood, is carried to the nervous mass and other tissues, and results in their oxygenation, a slow form of combustion, which is but a difference in degree with the burning of the candle. If, then, the nitrous oxide, as can be readily demonstrated, yields up its oxygen to support the burning of a candle, where is the philosophy in denying that it may also as freely give up its oxygen to a tissue which has such a strong affinity for it as the nervous mass, when they are brought in direct contact with each other?

In addition to these arguments, it should be remembered by the readers of this magazine, that in cases of impending asphyxia from drowning, hanging, inhalation of noxious vapours, &c., on the part

of a number of animals experimented upon by my friend and co-labourer, Dr. Geo. J. Ziegler, animation was promptly restored in every case by the injection of nitrous oxide water into the intestines of the animals. In these cases the efficacy of this agent in supplying oxygen to the blood and the nervous mass was most satisfactorily demonstrated.

If we assume that the influence of anæsthetics is dependent not upon a direct action on thenerve centres, but to an altered condition of the blood and the suspension of oxygenation, we must apply the same principle to all diffusible stimulants.—*The Dental Cosmos.*

VII.—*Note on the Blood-vessel-system of the Retina of the Hedgehog.* By J. W. Hulke, F.R.S.

The distribution of the retinal blood-vessels in this common British Insectivore is so remarkable that I deem it worthy of a separate notice—*only capillaries enter the retina.*

The vasa centralia pierce the optic nerve in the sclerotic canal, and, passing forwards through the lamina cribrosa, divide at the bottom of a relatively large and deep pit in the centre of the intra-ocular disk of the nerve, into a variable number of primary branches, from three to six. These primary divisions quickly subdivide, furnishing many large arteries and veins, which, radiating on all sides from the nerve-entrance towards the ora retinæ, appear to the observer's unaided eye as strongly projecting ridges upon the inner surface of the retina. When vertical sections parallel to and across the direction of these ridges are examined with a quarter-inch objective, we immediately perceive that the arteries and veins lie, throughout their entire course, upon the inner surface of the membrana limitans interna retinæ, between this and the membrana hyaloidea of the vitreous humour, and that only capillaries penetrate the retina itself.

In sections of the retina across the larger vessels the membrana limitans may be seen as a clean distinctly unbroken line passing over the divided vessels, with which it does not appear to have any direct structural connection. The relation of the hyaloidea to the large vessels seems to be more intimate, but its exact nature can be less certainly demonstrated, owing to the extreme tenuity of this membrane. In my best sections I saw the hyaloidea also crossing the large vessels, as does the limitans, but excessively delicate extensions of the hyaloidea appeared to me to lose themselves upon the vessels.

The capillaries, shortly after their origin, bend outwards away from the large vessels, and, piercing the retina vertically to its stratification in a direction more or less radial from the centre of the globe and branching dichotomously in the granular and inner granule-layers, they form loops, the outermost of which reach the intergranule-layer. As they enter the retina the membrana limitans interna is prolonged upon the capillaries in the form of a sheath, which is wide and funnel-like at first, but soon embraces the vessels so closely as to become indistinguishable from their proper wall; so that, notwithstanding the existence of a sheath, there is no perivascular space about the retinal capillaries, such as His has described in the brain or spinal cord, and has stated to occur in the retina and elsewhere.

In all other mammals, except the hedgehog, as far as my present knowledge extends, the arteries, veins, and capillaries lie *in* the retina. In fish, amphibia, reptiles, and birds, however, as H. Müller and others (myself as regards amphibia and reptiles) have shown, the retina is absolutely non-vascular, the absence of proper retinal blood-vessels being compensated for in fish, amphibia, and some reptiles by the vascular net which in these animals channels the hyaloidea, and by the highly vascular pecten present in other reptiles and in birds. Thus it is possible to divide vertebrates into two classes, according as their retina is vascular or non-vascular; and these classes would be connected by the hedgehog, the larger branches of whose vasa centralia lying upon the membrana limitans in intimate relation with the hyaloidea, represent the equivalent vessels of the hyaloid system, which forms so exquisite a microscopic object in the frog; whilst the capillary vessels channelling the retinal tissues occupy the same position which they do in most mammalia.

[The drawings in illustration of this paper are preserved for reference in the Archives of the Royal Society.]—*Proceedings of the Royal Society, May*, 1867.

VIII.—*A new Process of Preparing Specimens of Filamentous Algæ for the Microscope.* By A. M. Edwards.

The working microscopist well knows how little really valuable information, of a practical character, is to be found in books professing to treat of the subject of preparing and mounting specimens of the lower families of Algæ, so as to exhibit in a satisfactory manner the characters which distinguish them in a generic or specific manner. This remark also applies, although with not so

much force, to other branches of microscopic manipulation, as there are really many valuable hints to be found in the books descriptive of preparing woods, bones, and other hard tissues, and the subject of injecting has received much attention, so that the labours of the student are very materially lightened by the perusal of the works of the German, English, and French manipulators. But in microscopic botany our information is woefully deficient and old. The microscopist is, therefore, driven to the necessity of experimenting, and, as a consequence, discovering for himself. As the students of the lower families of plants are at the present time somewhat numerous, the result has, of course, been the development of many extremely valuable processes tending to simplify their study; but it is to be regretted that, whether from extreme modesty, or perhaps from some other cause, such as the fear that their processes are not new, or would not be appreciated, these gentlemen have, unfortunately, failed to publish. It cannot be denied that this mode of action is wrong, and that no one has a right to withhold the knowledge he may possess on such points. For my part I have taken every opportunity of publishing, or otherwise making known, any little point in manipulative microscopy which I have found of value, and which I have thought would in any way be of use to others.

For years I have been engaged in the study of the lower families of Algæ, more especially the Diatomaceæ, and for the purpose of eliminating their characters, I have at different times experimented upon the preparation and preservation of these beautiful forms, so as to be enabled at any future time to exhibit them in the best manner for showing their peculiarities. I have already published processes for obtaining the siliceous loricæ of Diatomaceæ from guano, and also several modes of collecting, preparing, and mounting, for the microscope these organisms. It is now my intention to make known a process I have contrived by means of which the filamentous forms of Diatomaceæ, Desmidiæ, and Confervæ, can be preserved and mounted so as to show many of their characters, although, as is always the case, something has to be sacrificed. However, it is my opinion the best process that has been as yet made public, and even if it is of no other value, I trust it will have the effect of drawing from others records of their modes of manipulation, so that searchers after truth, like myself, may learn something of value to them in their investigations.

It is well known that the Desmidiæ and the filamentous Algæ, generally found growing in fresh water, have never been preserved in a satisfactory manner, and this has arisen from the fact that their cell-walls are composed of a substance of a perishable matter, and will not, like that of the Diatomaceæ, which is siliceous, bear boiling in corrosive liquids so as to remove the always readily

decomposable cell contents, and leave the object clean and transparent, while the Diatomaceæ, after such treatment as boiling in acid, can be mounted in Canada balsam, by means of which they are presented in such a state that the finest sculpture of their siliceous epidermis can be observed, and they are at the same time held within a preservative substance which does not permit of their movement and consequent danger of fracture; the Desmidiæ and the filamentous Algæ in general cannot be preserved so, and several means have been devised to keep them, all of which have been to a certain extent unsatisfactory. Besides, there are some Diatomaceæ which grow in chains, as the Fragillaria, the frustules of which are united by means of a substance that will not bear the contact of acid necessary to remove the cell contents; and again there are others, as the Gomphonema, which are attached to submerged substances by means of a flexible stalk called a stipe, which would dissolve under the same circumstances. Such Diatomaceæ have been generally merely placed in a cell formed of cement, or other suitable substance, and preserved in a preservative solution, consisting either of pure distilled water, or water containing creosote, camphor, or other substance possessing antiseptic properties. And the same plan has been followed with the filamentous Desmidiæ and other Algæ, but such specimens become, after a short time, unsightly. It is true that the general outline is preserved, but the cell contents either contract or change in form and colour, so as to injure the appearance of the specimen, or the same effect is brought about by the coloured matter generally accompanying gatherings of such organisms.

My plan then is essentially as follows:—Supposing I have a gathering consisting for the most part of a filamentous Desmid, as *Desmidium Swartzii*, which is a common species around New York city at certain periods of the year, I place a small quantity of it in a test tube, and pour over it, so as to about quarter fill the tube, a strong solution of the so-called "chloride of soda," which I prepare for the purpose in the following manner. Those, however, who have not the facilities for doing so, or do not desire to prepare their own solution, can use that sold by the apothecaries under the name of "Labarraque's Solution of Chloride of Soda," which is, however, rather weaker than it is best often to use. My solution I make by adding to the water a large excess of the common chloride of lime of the shops, which is fresh and has not stood for a time in an open vessel exposed to the air, by means of which much of it becomes decomposed and useless for this purpose. After stirring well, and then allowing such a mixture to stand for a short time, until all that will not dissolve falls to the bottom, I pour off the clear liquid, and add to it a concentrated solution of carbonate of soda, the common "washing soda," until the white

precipitate of carbonate of lime, or chalk, ceases to form. The clear solution is now poured off, preferably through a good paper filter, and preserved in a well-corked bottle, away from the light. This is my solution of chloride of soda. The Alga is now boiled for a few minutes in the solution, but not so violently or for such a length of time as to break up the filaments, and then well and thoroughly washed with pure filtered or distilled water. It can thereafter be preserved in weak spirits, or, what I have found still better, water to which a few drops of creosote have been added. Thus the growth of fungi is prevented, which would otherwise mar the appearance of the object very materially.

To mount such bleached specimens, I proceed as follows. Those which have been set aside in creosote water may be, of course, put up permanently in that liquid, but those which have been preserved in spirits, I prefer to mount in creosote. A cell is procured of any suitable substance, as black varnish, gold size, marine glue, or other cement which will withstand the action of water, and a fragment of the Alga being placed in it in the usual manner, water is added, and a fine glass rod or stick of wood, just moistened with creosote, brought in contact with the liquid. In this way the water becomes sufficiently impregnated with the preservative to ensure its antiseptic action. The cover is then put on and cemented down. Thus we have a specimen of the Alga in a transparent condition, all colours which interfere with the observation of many points being removed. In place of creosote water I have made use of camphor water, and found it to answer admirably. The camphor water I make by using distilled water, and, just before placing on the cover, putting in a grain of gum camphor, which then remains in the cell, and if near the edge does not mar the appearance of the object in any way. Specimens can also be mounted in the glycerine-jelly of Mr. Lawrence, which preservative I find to be excellent for all kinds of Algæ and vegetable preparations generally; in fact, after a little practice, the manipulation of it becomes almost as easy as that of balsam, and air bubbles, those torments of beginners, are the exception, and not (as is the case for a long time generally after a tyro begins mounting microscopic objects) the rule. Of the use of this jelly, or rather a modification of it, I shall at some future time have more to say.*

* From the 'American Naturalist,' May.

NEW BOOKS, WITH SHORT NOTICES.

An Introduction to the Classification of Animals. By Thomas Henry Huxley, LL.D., F.R.S. London: Churchill, 1869.—This work, the author tells us in his preface, contains the substance of the six lectures which form the first part of his treatise 'On the Classification of Animals.' In addition, it contains definitions of all the most important orders of the animal kingdom. It is brought out in its present form because it is likely to prove useful as a text-book, and because the work in which its matter first appeared is now out of print. We do not hesitate to say that, in reproducing this part of his lectures, Professor Huxley has conferred a great boon on both lecturers and students. Hitherto the student has had to wander in a very wilderness of text-books, most of them full of old and exploded doctrines, and many of them, even of recent publication, more remarkable for the startling character of the ideas they inculcate than for any sound philosophical teaching. But in the admirably-prepared and well-illustrated volume before us, the lecturer will find a work which he can conscientiously recommend to his pupil as embodying the latest research on those points in comparative anatomy which are concerned in the establishment of principles of classification, and as containing no "loose matter," but, on the contrary, most cautiously-worded and carefully-digested definitions and statements of fact. It is very much the custom among scientific men to jumble together a lot of facts with careless arrangement, and to call this kind of thing a text-book; and, indeed, such treatises are the ruin of our schools. Of quite another stamp is the book of Professor Huxley. It is perfectly clear to even a casual reader that in everything that he has written for the student the author has weighed his words well, and that when a doubt has existed in his mind he has openly expressed it with the candour and precision which are so characteristic of all his writings. Perhaps some of our readers will think our criticism ecstatic, but from a long and painful experience of the miserably inexact nature of natural-science text-books, we are, we believe, not outstepping the bounds of impartial judgment when we pronounce this volume to be the best work for students that has yet appeared in our language.

The system of classification adopted by the author is so well known to students of zoology that we need not enter upon it in these pages. Nor, indeed, need we do more in conclusion than point out the general features of the work. There are six chapters in the volume, and the titles of these are sufficiently indicative of the range of subject dealt with by Professor Huxley.

These title-headings are as follows:— On Classification in General; The Characters of the Classes of the Invertebrata; The Characters of the Classes of the Vertebrata; On the Arrangement of the Classes into Larger Groups; The Sub-classes and Orders into which the Classes of the Vertebrata are divisible; The Orders into which the Classes of the Invertebrata are divisible. The first chapter extends over no more than about five pages, and yet is a masterpiece in the simplicity of style in which it lays some difficult abstract considerations before the mind of the student. The aim, *raison d'être*, and the general basis of the principles of classification, involve in their explanation considerable metaphysical difficulties; and we know of no harder task than to have to expound these things to the young student. Nevertheless, we think Professor Huxley has done so in his happiest style, and we only wish we could reproduce this chapter *in extenso*. Referring to the mistake which some anatomists make of confounding the admission of a causal connection of natural phenomena with an affirmation of our knowledge of the nature of "that causal connection," Professor Huxley makes the following remarks, which we beg to quote in concluding our observations on this excellent book:—

"Cuvier, the more servile of whose imitators are fond of citing his mistaken doctrines as to the nature of the methods of palæontology against the conclusions of logic and of common sense, has put this so strongly that I cannot refrain from quoting his words: 'But I doubt if any one would have divined, if untaught by observation, that all ruminants have the foot cleft, and that they alone have it. I doubt if any one would have divined that there are frontal horns only in this class; that those among them which have sharp canines for the most part lack horns. However, since these relations are constant, they must have some sufficient cause; but since we are ignorant of it, we must make good the defect of the theory by means of observation; it enables us to establish empirical laws which become almost as certain as rational laws, when they rest on sufficiently repeated observations; so that now whoso sees merely the print of a cleft hoof may conclude that the animal which left this impression ruminated, and this conclusion is as certain as any other in physics or morals. This footprint alone, then, yields to him who observes it the form of the teeth, the form of the jaws, the form of the vertebræ, the form of all the bones of the legs, of the thighs, of the shoulders, and of the pelvis of the animal which has passed by: it is a surer mark than all those of Zadig.'" *

* 'Ossemens Fossiles:' éd. 4me, t. 1er, p. 184.

PROGRESS OF MICROSCOPICAL SCIENCE.

A New Sponge, which appears to be closely related to Euplectella, has been described by Professor Leidy. The specimen on which the genus *Pheronema* is founded was captured at Santa Cruz, and reminds one, says Dr. Leidy, of the Hyalonema, with its siliceous rope, but the structure of the threads more nearly resembles that of the anchor threads of Euplectella. The body of the sponge is oblong ovoidal, with the narrower end upward, and with one side more prominent than the other. The lower extremity is rather cylindroid and rounded truncate. The upper extremity is conical, with a truncate apex presenting a large circular orifice. This is about four lines in diameter, and is the exit of a canal which descends in the axis of the sponge for almost half its depth, and then appears to divide into several branches. The sides of the sponge form thick dense walls to the cylindrical canal, which is of uniform diameter before its division. In its present condition the sponge is of a light-brown hue. Its surface exhibits an intricate interlacement of stellate, siliceous spiculæ, including a tissue of finer spiculæ of the same character, the whole associated by the dried remains of the softer sponge tissues. More or less fine sand, especially at the lower end of the sponge, appears to be introduced as an element of structure. From the lower end of the sponge there projects a number of distinct or separate tufts of siliceous spiculæ, looking like tufts of blonde human hair. In the specimen there are fifteen tufts projecting around two-thirds of the extremity of the sponge, but the remaining third of the extremity of the latter exhibits about ten orifices, from which as many additional tufts appear to have been extracted. Length of the body of the sponge 4½ inches; diameter at middle 22 lines, at lower end 15 and 17 lines, at upper end 8 lines. Length of tufts of spiculæ 2 inches. The coarser stellate spicules of the surface of the sponge in general have five rays, of which four are irregularly cruciform, while the fifth projects at a right angle to the others towards the interior of the sponge. The rays of the contiguous crosses form together a lattice-work on the surface of the sponge, and the intervals are covered by the rays of the finer spiculæ, which also in general have a five-rayed stellate character. The finer tissue in the interior of the sponge, seen through the lattice-work of the surface, contains a multitude of spicules which differ from the others only in their minute forms. Some of the largest stellate spicules on the surface of the sponge have a stretch of three-fourths of an inch. The spicules of the tufts projecting from the sponge are two or three inches in length, and vary in diameter. They become attenuated towards both extremities, but especially that inserted into the sponge-mass. Starting from the latter, they are at first smooth, then finely tuberculate; the tubercles gradually become converted into well-marked recurved prickles or hooks, and finally the spicules end in a

pair of longer hooks, recalling to mind the arms of an anchor. The spicules bear a near resemblance to those at the lower extremity of Euplectella, but have only two instead of four hooks at the end. In the specimen but few of the spicules present the complete character as described, most of them apparently having been broken. The object of the tufts of spicules, with their recurved prickles and anchor-like free extremities, in *Pheronema* would appear to be to maintain the position or preserve the anchorage of the sponge in its ocean home, and perhaps in the living animal they are incessantly produced as occasion may require, just as a *Mytilus* or a *Pinna* renews and attaches its threads of byssus to secure its position. The siliceous spicules of *Pheronema* are composed, as in sponges generally, of concentric layers, and exhibited a delicate tubular axis. A spicula from one of the tufts measured as follows:—Spread of the anchor, one-tenth of a line; shank of the anchor, one-thirtieth of a line; prickled portion of shaft, one-fortieth of a line; shaft where thickest and without prickles, one-eighteenth of a line, thinning out to the inserted end, where it was not more than 1-300th of a line.

The Structure of the Cotyledon in Monocotyledons.—This subject has occasioned some controversy between the two eminent botanists MM. Van Tieghem and Lestiboudois, who have been fighting out the question in a series of papers before the French Academy. We must confess that the rival debaters have not put their respective opinions forward with that degree of clearness which is desirable. But so far as we can gather the meaning of the discussion, the question stands thus:—M. Van Tieghem holds that, in Monocotyledons as well as in Dicotyledons, the cotyledon generally receives, as do the other leaves, an odd number of bundles, and that its symmetry, and consequently that of all its appendages, is the same in the two divisions. The number of cotyledonary bundles is smaller than that of the primitive vascular planes, which in the central body of the root alternate with as many other bundles, and the median nervure corresponds to one of these primitive vascular bundles. A subsequent note by M. Lestiboudois implies that he too, holds this opinion, and that the view contested by M. Van Tieghem was that which he considered applicable to the primordial and not to the secondary leaves of the Monocotyledon. —See 'Comptes Rendus,' April 26th and May 3rd.

The Lymphatics of the Epithelium.—A paper of much importance, since it shows us the danger of accepting the appearances produced in tissues by means of reagents, as representing the living condition, was sent in to the French Academy of Sciences by M. Robinski, at a recent meeting (April). Alluding to M. Recklinghausen's use of nitrate of silver to stain the tissues, he says, that he has seen how the pseudo-lymphatics are formed in the epithelium by this salt. "The lines of demarcation," he says, "of the epithelium cells are always stained a deep brown colour, while the middle of the cell is seldom coloured, owing to the fact that the colour has to pass from the margin towards the centre. It happens thus, that while the whole preparation is more or less brown, that certain cells are unstained. According to

their number and arrangement, these cells form clear spaces of various configurations, which have by different observers been regarded as the trunks and orifices of lymphatic vessels. An analogous explanation accounts for the epithelium of these pretended lymphatic vessels.

The Structure of the British Nemerteans is the title of a paper some time since read before the Royal Society of Edinburgh. We have not seen the memoir itself, but the following abstract appears in the last number of the 'Proceedings' of the Society:—In the first part of the paper the anatomy and physiology of the Ommatopleans is described from the typical form *O. alba*, the variations and peculiarities presented by other genera and species being contrasted therewith. The descriptions are grouped under the following heads:—Dermal Tissues; Proboscidean Sheath; Proboscis; Digestive, Circulatory, and Nervous Systems; Cephalic Furrows, Pits, and Glands; Organs of Reproduction and Development. The second part consists of the structure and physiology of the Borlasians, under the same (or similar) heads, together with such anomalous genera as differ from both great groups of Nemerteans. The third division treats chiefly of the structure of certain (upwards of forty) annelids new to science or to Britain.

The Goblet-cells of the Epithelium of the Frog's Throat.—Dr. Michael Foster, who has been independently carrying on some researches upon this subject, recently so much gone into by Herr Boll, has given in the May number of the 'Journal of Anatomy and Physiology' an excellent paper on the general character of the epithelium of the frog's throat. He gives the following account of the so-called "Becher-zellen":—"The most common, perhaps the typical form, is that of a globe or of an oval flask with its neck broken off short. The lower pole of the globe is occupied by a mass of somewhat refractive cell-substance, in the midst of which may with difficulty be detected a shrunken nucleus, often a third less in size than the nucleus of the ciliate cells, with an inconspicuous nucleolus. The ordinary cell-substance round the nucleus varies somewhat in amount, and also in form. Not infrequently, like the corresponding end of the ciliate cell, it is continued into delicate branching processes. It is always more or less vacuolated. . . . . . The cavity thus occupying at least four-fifths of the total area of the cell is crowded with refractive spherules of variable size. . . . . . Sometimes these spherules are absent, and then the cavity is filled with mucus, and its walls are marked by a network of fine lines."

The Fine Anatomy of the Skin of Lizards has been investigated recently by Mr. J. W. Hulke, who has contributed a short paper on the subject to the 'Journal of Anatomy' for May.

The Anatomy and Mode of Division of Stentor.—Those of our readers—and they are legion—who are interested in Infusoria should read a very excellent paper on this subject by Dr. Moxon, of Guy's Hospital. It is published in the journal above mentioned, and is a most interesting communication. The author argues strongly against the idea that Infusoria require a circulatory system at all. His paper is accompanied by various drawings.

Structure of Tubipora musica.—Dr. E. Perceval Wright has been following up M. Lacaze-Duthier's line of research, and has given us ('Annals of Natural History,' May) a very good though short paper on the structure of the "Organ-pipe Coral." The author comments on Kölliker's statement in his 'Icones Histologicæ,' and points out that the structure of the skeleton of this coral, contrary to Kölliker's view, is certainly *not* crystalline. The development of the ovum has not been studied by the author.

NOTES AND MEMORANDA.

Lectures on the Microscope.—It is rumoured—and we hope on good foundation—that an experienced microscopist proposes next winter to give a series of general public lectures on microscopic manipulation. We think the idea a good one. Such lectures are regularly given in most medical schools. A course on "The Microscope in Physiology and Medicine" is, we perceive, being delivered now in the University of Pennsylvania.

Glycerine for Preserving the Natural Colours of Marine Animals has been very highly spoken of in a recent paper by Mr. A. E. Verrill, of Yale College, U.S. "The only precaution taken was to use *very heavy* glycerine, and to keep up the strength by transferring the specimens to new as soon as they had given out water enough to weaken it much, repeating the transfer two or three times, according to the size or number of the specimens, or till all the water was removed." Mr. Verrill says that this is an excellent method, that it preserves the colours better than any other process, and, finally, that it is by no means expensive.

A New Section Instrument has been described by Dr. J. Gibbons Hunt, at a late meeting of the Philadelphia Academy of Natural Sciences:—A brass tube, two inches long and three-fourths of an inch in diameter, is closed at one end; a circular brass plate two inches in diameter attached to the other end, and ground properly flat, forms the surface to guide the razor. Into this tube fits another, which is worked up or down by a screw working in a thread cut in the bottom of the outside tube. A slot cut *through the upper* end of the *outer tube* affords room for a lateral binding-screw, which is *attached to* and *carried* by the *inner tube*. The binding-screw presses against a moveable tongue of metal armed at the upper and inner side with minute points. On the opposite side of the inner tube are also points designed to hold an object more securely. The advantages of this improvement are obvious. It is cheap, and is peculiar in really answering the purpose for which it is made.

British Graptolites.—A very good paper on this subject has been

published in the 'Journal of the Quekett Club' (April), by Mr. John Hopkinson, F.R.M.S. The author gives a general account of the morphology of these fossil Hydrozoa, and tries to deduce from their history an argument against the theory of Natural Selection.

Mr. Crooke's Binocular Spectrum-Microscope.—This instrument, which is made by Mr. Collins, and was exhibited at the *soirée* of the Royal Society, has, we are informed, been devised to obviate the disadvantages of the ordinary spectrum-microscope. The principal features are the sub-stage and the box of prisms. The former carries a sliding-plate to hold the slit and apertures, a spring stop and screws for adjusting them, and a reversed object-glass. The slit and this object-glass are about two inches apart, and if reflected light is passed along the axis of the instrument, the object-glass forms a very small image of the slit in front of it. A milled head moves the whole sub-stage, and screws bring the image of the slit to any part of the field. Beneath the slit is an arrangement for holding an object of irregular surface or dense substance. The stage has a concentric movement, so as to permit the object to rotate, and enable the image of the slit to pass through it in any direction. The direct-vision prisms consist of three flint and two crown, fitted in a box screwed into the end of the microscope. By means of a pin they are thrown in or out of action. The object-glass screws on in front of the prism-box. By taking the illumination from the sky or a white cloud, Fraünhofer's lines are visible, and by direct sunlight they are seen in great perfection; the dispersion is sufficient to cause the spectrum to cover the whole field, and the achromatism of the lenses being nearly perfect, the lines from B to G are practically in the same focus. A double-image prism near the slit enables two spectra to be seen, oppositely polarized, and the variations in the absorption lines are at once visible. A Nicol's prism as polarizer, and another as analyzer, can be connected, and these enable the brilliant colours shown by some crystalline bodies, when seen by polarized light, to be examined. If a substance is dark-coloured, or the illumination not brilliant, the whole of the light should be passed up the tube to one eye; but when the light is good, the appearance of the spectrum, and the power of grasping faint lines, are greatly improved by dividing the light with a Wenham prism, and using both eyes; whilst the stereoscopic effect thereby communicated to some absorption and interference spectra, throws a new light on the phenomena. By using a spirit lamp instead of the illuminating lamp, the instrument answers admirably for examining flame spectra. The characteristic yellow, crimson, or green lines are seen beautifully sharp, on introducing sodium, lithium, or thallium into the flame.

A Live-Box, which may be found useful by some of our readers, is described by Mr. J. W. Meacher in 'Science-Gossip' for May.

PROCEEDINGS OF SOCIETIES.*

ROYAL MICROSCOPICAL SOCIETY.†

KING'S COLLEGE, 12*th May*, 1869.

The Rev. J. B. Reade, F.R.S. (President), in the chair.

The minutes of the previous meeting were read and confirmed.

The President said he wished to make a remark on that portion of the minutes which related to the two papers which had been "taken as read." As was well known, there was not time at the last meeting to read these papers; and as it was intended that both papers should appear in the Society's journal, he had hoped that the discussion on Mr. Suffolk's paper on "The Proboscis of the Blow-fly," would have taken place conjointly with that which might follow the reading of Mr. Lowne's paper announced to be read that evening. Owing, however, to the illness‡ of the editor of the journal, the publication of Mr. Suffolk's paper (though it was in print) had been unavoidably delayed. Nevertheless he, the President, should feel disappointed if the meeting was not put in possession of the facts which Mr. Suffolk desired to communicate; and he proposed therefore that, as Mr. Suffolk's thorough acquaintance with the subject would enable him to do it, he should give a *résumé* of his paper, at the close of Mr. Lowne's paper.

A list of donations to the Society was then read, and a vote of thanks passed to the donors.

The President said he had received a communication from Mr. George Busk, F.R.S. (who had been one of the editors of the former journal of the Society), stating that in consequence of his numerous and pressing engagements, both public and private, he found it impossible to attend the meetings of the Society, and he had therefore very unwillingly decided to tender his resignation of the Fellowship which he held in the Society.

The council, on the other hand, were equally unwilling to terminate their connection with Mr. Busk, not only on account of the deep interest which he had taken in the Society, but also from their know-

* Secretaries of Societies will greatly oblige us by writing out their reports legibly—especially the technical terms—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—ED. M. M. J.

† Report supplied by the Secretaries.

‡ This statement, which the President was kind enough to make, while perfectly correct in point of fact, is really not the explanation of the matter. The answer to the difficulty is a simple one, and is this. The Editor is allowed but two plates in each number of the 'Journal.' An excellent paper of the Society's—Mr. Sanders's—had the priority of Mr. Suffolk's paper, and demanded a plate and a half in illustration. Mr. Suffolk's paper required four plates, and therefore the Editor, much to his own inconvenience and with great regret, was compelled to *allow it* to stand over.—ED. M. M. J.

ledge of his great worth, and vast attainments. They had, therefore, resolved to propose to the Fellows that they should elect Mr. Busk as an Honorary Fellow.

The resolution was passed *nem. con.*

The names of gentlemen who were to be balloted for were then read.

Mr. Slack announced that Mr. Field, of Birmingham, had sent a dissecting microscope for the inspection of the Fellows; and that it would be upon the table for that purpose at the close of the proceedings.

The President then called upon Mr. B. T. Lowne, M.R.C.S., to read a paper on "The Rectal Papillæ of the Blow-fly."

No discussion followed the reading of this paper, and a vote of thanks was unanimously passed to Mr. Lowne for his interesting communication, which the President said he confessed to have been entirely new to him, and he presumed to most of the Fellows present.

The President then requested Mr. W. T. Suffolk to give a summary of the paper to which allusion had been made.

Mr. Suffolk then delivered the substance of his paper, illustrating his remarks by various drawings which he had prepared. He explained that the engravings which had been made for the journal were anything but what he should like the Society to possess, as the engraver had completely misinterpreted the drawings which he (Mr. Suffolk) had made.

Mr. Suffolk also mentioned the fact that the drawings had been executed direct from the microscope, without the aid of camera lucida, by means of a small glass disc ruled into squares; the disc fitting into the eye-piece in the usual place of the micrometer; and the paper used being also ruled in squares of suitable dimensions. By this contrivance the microscope can be used in its usual position, and without fatiguing the eye, as in the case of the camera lucida. Messrs. Beck had supplied the ruled plate, the sides of the squares corresponding with ten degrees of their Jackson's micrometer.

Mr. Lowne's name having been mentioned in connection with certain organs of the proboscis described by Mr. Suffolk, the President requested Mr. Lowne to make a few observations on the organs in question. Mr. Lowne accordingly explained the structure of the fulcrum, the mouth of the fly, and the ligula. He also drew the attention of the meeting to an extraordinary valve which was attached to the salivary tube of the blow-fly, and which he believed he had been the first to describe. His views on the whole subject were expressed in a work which he was just about to publish. He would, without wishing to depreciate Gleichen's work quoted by Mr. Suffolk, express his opinion that it was very far from exhaustive, and many of the drawings he considered very incorrect.

Mr. Suffolk explained that he had adduced the work only as very correct for the period at which it was written.

The President said he would ask Mr. Lowne his opinion with respect to the Pseudo-tracheæ, which had been described by Mr. Suffolk. The examination which he had made many years ago had

led him to the conclusion that the pseudo-tracheæ were in reality tubes, by which, when the fly was sucking blood or other fluids, they would be drawn up into the tubes, thence through the main channel passing into the fly's stomach. The observations which he had made were communicated to a meeting of gentlemen in 1837, at the house of Dr. Bowerbank, and he (the President) had very lately had a singular opportunity of confirming those observations, at the house of his friend Dr. Millar.

He (the President) had been accustomed to prepare the proboscis for examination by squeezing the fly. The pressure caused the organ to protrude; and tying it at the bottom with a thread of very fine silk, he put it on the slip of glass, and then under the binocular; by this means obtaining a beautifully clear view of the organ. There was this drawback in the mode of preparation just described, for the object soon dried up. But the pressure incidental to Mr. Topping's plan was avoided, and the parts of the proboscis were seen quite in their natural position.

His friend Dr. Millar, in anticipation of the paper of Mr. Suffolk, had collected some 200 or 300 flies. Two of these he (the President) had put into a fly-box with a little meat and blood. They immediately attacked the blood, and in a few seconds appropriated it. Then squeezing them as before described, and mounting them at once, he saw under the binocular every tube to be distinctly filled with blood. He wished to know whether, in Mr. Lowne's opinion, the pseudo-tracheæ had a definitely tubular character. He believed they were tubes with a small aperture at their extremity which acted as a filter, preventing the ingress of anything that might be injurious to the fly while it was feeding itself.

Mr. Lowne, in reply, stated that he quite concurred in the idea that the pseudo-tracheæ were tubes, but with this qualification, *viz.* that they opened by means of numerous slits which extend the whole length of their under-sides.

The President then said that at Mr. Lee's request he would describe a small but effective addition he had just made to the "kettledrum," or double hemispherical condenser. By the super-position of a third lens he had been able to show the *rhomboides* in a most satisfactory manner to his friend Dr. Millar under the $\frac{1}{12}$th-inch object-glass, the markings being very distinctly visible over the whole surface of the valve, and appearing as black as jet. With the $\frac{1}{4}$-inch power the object was also seen with great distinctness.

The condenser consisted at present of two hemispherical lenses with an adjustable diaphragm between them for the necessary regulation of the intensity of the illuminating pencils. On the surface of the upper hemisphere he had placed a disc of tinfoil pierced with the usual apertures at right angles to each other for rectilineal markings. These apertures were made to coincide exactly with the apertures of the adjustable diaphragm. Then, upon the top of the upper hemisphere he placed a third lens of about two inches solar focus, the lens used being the field glass of the B eye-piece with its plain side uppermost.

The increased obliquity thus given to the emergent pencils by means of this third lens causes the finest lines and markings to be brought out with unusual distinctness. What is wanted for the closest lines is the greatest obliquity possible. Those who happen to have the double condenser would find the addition and adjustment of this third lens very easy, and the working of the instrument much improved by the greater obliquity of the emergent pencils. The lamp, as the source of direct light, should be placed about 10 inches from the stage of the microscope, the rays being rendered parallel by a bull's-eye condenser.

The next meeting will be held on June the 9th, which will be the last this season.

Donations to the Library, May 12, 1869:—

	From
Land and Water. Weekly	*Editor.*
Scientific Opinion. Weekly	*Editor.*
Society of Arts' Journal. Weekly	*Society.*
The Student	*Publisher.*
On British Graptolites. By J. Hopkinson	*Author.*
The Quinology of the East Indian Plantations. By John E. Howard. F.R.M.S., &c.	*Author.*
Papers and Proceedings of the Royal Society of Tasmania, 1866–7	*Society.*
Journal of the Geological Society, No. 98.	*Society.*
On some New Species of the Genus Unio. By Dr. J. Lea	*Author.*
Försök till en Monograph öfver Monstroma. Af V. B. Wittrock	*Author.*
Algologiska Studier. Af V. B. Wittrock	*Author.*
Smithsonian Reports for 1863–5	*Society.*

The following gentlemen were elected Fellows of the Society:—

Joseph Dickson, Esq., M.D.
W. Ford Stanley, Esq.

Walter W. Reeves,
Assist. Secretary.

Quekett Microscopical Club.*

At the ordinary meeting, held at University College, on April 23rd, Arthur E. Durham, Esq., F.L.S., President, in the chair,—eleven new members were elected, and twenty gentlemen were proposed for membership. A number of donations to the club were announced, including slides to the number of 173. The President gave notice that the next meeting would be made special for the consideration of important alterations in the bye-laws, and the rules as proposed to be amended were severally read over by the Secretary. Mr. B. T. Lowne read a highly interesting paper, entitled "Some further Remarks on the Proboscis of the Blow-fly," being supplemental to a paper which he read upon the same subject at the meeting of the club in November last. The paper—which was illustrated by

* Report supplied by Mr. R. T. Lewis.

diagrams, and by preparations exhibited under the microscope—was listened to with great attention, and led to an interesting discussion, in which the President, Dr. Braithwaite, Messrs. Suffolk, Hainworth, and Lowne, took part. Mr. Love exhibited and described a new form of turn-table, so constructed as to be self-centering, and in which by a slight alteration in the shape of the pin the unsteadiness consequent upon the wearing away of the hole was entirely obviated. Dr. R. Braithwaite exhibited a specimen of moss (*Antitrichæ Pendula*) which he had recently gathered in the forest of Fontainebleau, where it was very abundant, growing upon trees in large tufts. Specimens were freely distributed amongst the members at the close of the meeting. Mr. Breese made a short communication on a method of making thin sections of vegetable structures, by saturating them in a solution of gum, and afterwards drying. When so prepared sections might easily be cut from the most delicate tissues, the gum being afterwards dissolved out if required. A paper by Mr. Kitton was taken as read, and ordered to be printed in the journal of the club. The Secretary read a letter from Mr. Fitch, stating for the information of members that Melicerta and Stephanoceros might be found in great abundance in a pond opposite the Manor House at Finchley. A letter was also read from the Rev. E. C. Bolles, of Portland, Maine, U.S.A., expressive of his thanks to the members on the occasion of his election as an honorary foreign member of the club. The President announced that the monthly conversational meetings of the club would be continued through the summer, the council of University College having most courteously granted the use of their library for the purpose. The proceedings terminated with a conversazione, at which a variety of interesting objects were exhibited.

Literary and Philosophical Society of Manchester.

Microscopical and Natural History Section.

March 29th, 1869. J. B. Dancer, F.R.A.S., President of the Section, in the chair. Mr. Robert B. Smart, M.R.C.S., was elected a member of the section.—The Rev. J. E. Vize, M.A., of Calveley, communicated some notes respecting the kangaroos of Beeston Castle. Mr. Walter Morris gave an account of a pair of kangaroo rats from Australia, kept by him some years ago. These were in shape precisely like the large kangaroos, but were only about six inches high when resting on their hind legs—their characteristic posture. Mr. Sidebotham exhibited some very fine spikes of *Celsia Cretica*, but, instead of the bright yellow flowers, they were apetalous. Rev. J. E. Vize, M.A., forwarded a spike of the common plantain (*Plantago major L.*), which had bifurcated from the middle of the inflorescence, each portion producing perfect fruits. Amongst other vegetable monstrosities mentioned was that of a dandelion, which Mr. Hunt had collected some time ago, having several scapes united so as to form a single flat ribbon-like stalk, crowned by the various involucras, more or less blended together.

Brighton and Sussex Natural History Society.*

May 13th. The President, Mr. Glaisyer, in the chair.—A Microscopical meeting. Mr. Wonfor, Hon. Sec., read notes by Mr. T. B. Horne on a series of Anthozoa and Polyzoa collected during the preceding two months at the Isle of Wight by that gentleman and a daughter of the President.

The specimens were afterwards exhibited by the President, the most noticeable being *Sertularia operculata* (from the resemblance of the vesicles in this species to the urns of mosses, botanists were, at one time, led to claim them for the vegetable kingdom), *Plumularia cristata*, *Crisidia cornuta*, *Anguinaria spatulata*, *Notamia bursaria*, and *Bugula calattira* with bird's-head processes.

The Rev. J. H. Cross exhibited an interesting series of sections of forest and tropical trees, entomological preparations, and diatoms.

Mr. Gorringe showed foraminifera, Australian diatoms, butterflies' wings, feathers, and hairs.

Mr. T. Cooper exhibited sections of cedar, human hair, and textile fibres.

Mr. Simonds exhibited antheridia and zoospores of *Fucus serratus*, jungermania, Sphagnum, polystomella from Shoreham Harbour, and palates of mollusca.

Mr. Pete showed, under polarized light, sections of rocks of igneous origin, among which were granites, serpentine, jasper, pitchstone (a very peculiar arborescent crystallization), quartz, and lava from Mount Hecla, the two last containing fluid cavities, and a very fine crystallization of agate, called from its arrangement and the gorgeous display of colour, "ribbon" agate.

Mr. R. Glaisyer showed ova of the toad, a curious fungus, one of the *physomycetals* found inside a lump of Turkey opium, various seeds, and living larvæ of the poplar hawk moth just emerged from the egg. These last were shown under a very cheap but remarkably good four-inch objective, by Norman, of City Road, London.

Mr. Wonfor exhibited various salts crystallized at high temperatures, in which either a radiating or spiral form was seen, the most remarkable were aniline, hippuric acid, phloridzine, santonine, and sulphate of copper. In the copper the spirals were as true as if mathematically ruled; plumules and battledore scales from the males of various families of butterflies, in which they are marks of sex, *i. e.* found only on the upper side of the wings of males. These were illustrative of two papers read by him before the Society, "On certain Butterfly Scales, characteristic of Sex," and since published. Also drawings and engravings of the same, and the insect "porcupine" *Tingis hystricellus*, which attracted attention at the April meeting of the Society.

* Report supplied by Mr. T. W. Wonfor.

Bradford Microscopical Society.

The ordinary monthly meeting was held on May 12, when a paper was read by Mr. Prince on "Drawing from the Microscope." The difficulties found by beginners in the use of the camera were explained, and some useful hints given as to the best means of keeping the pencil-point in sight without losing the object. Attention was called to a disguised camera-obscura, which a writer in 'Science-Gossip' has lately proposed, though without a word about the dark chamber which that process requires. A very convenient apparatus was described and exhibited in use, by means of which the camera can be instantly applied to any microscope without altering the position of the instrument or removing the lamp.

Birmingham Microscopical Society.

At a recent meeting of the Birmingham Natural History and Microscopical Society, Dr. James Hinds read a paper on the "Microscopical Structure of the Liver," illustrating his remarks by numerous diagrams and by admirably-prepared microscopical objects. He entered minutely into the structure of the lobules and the distribution of the various blood-vessels, directing especial attention to the several views which have been put forward in respect to the commencement of the hepatic ducts.

Among specimens exhibited by members, the following may be mentioned :—

Mr. Bolton, the exquisite Rotifer, *Melicerta ringens*, "who, not content with dwelling, like the Floscules, in a gelatinous bottle, is at once brickmaker, mason, and architect, and fabricates as pretty a tower as it is easy to conceive ;" *Æcistes crystallinus*, another tube-dwelling Rotifer, which, "although less beautiful than the Floscules or the Melicerta, is nevertheless a pretty and interesting object ; *Vaginicola valvata*, distinguished by the remarkable valve existing in its sheath or case ; also, specimens of Epistylis and Stentor.

Mr. C. Pumphrey, *Stephanoceros Eichornii*, perhaps the most beautiful of all the Rotifers, thus described by Slack, in 'Marvels of Pond Life':—"In this elegant creature, an oval body, somewhat expanded at the top, is supported upon a tapering stalk, and stands in a gelatinous case. That which constitutes the glory of this little being is a crown of five tapering tentacles, each having two rows of long cilia arranged on opposite sides, but not in the same plane. When well exhibited, the tentacles have a lustre between glass and pearl ; the body, in a favourable position, is like a crystal cup ; and the food, usually composed of small red and green globes, glows like emeralds and rubies, as if, in the height of luxury, the little epicure had more than rivalled Cleopatra's draught, and instead of dissolving, swallowed its jewellery whole."

Mr. Morley contributed :—*Pulmonaria officinalis* (lung-wort), from Elmdon.

Mr. Madeley, the fresh-water Alga, *Vesiculifera Mulleri* (in fructification).

Mr. T. C. Parsons, the rare *Vaucheria polysperma* (belonging to the same tribe of plants), exhibiting the singular mode of reproduction characteristic of that genus.

Mr. J. L. Phelps showed eggs of *Gallinula chloropus* (water-hen); Mr. Simpson, the circulation of blood in the tail and branchiæ of tadpole; and Mr. Shoebotham, transverse sections of *Triticum sylvaticum*, showing the structure of the albumen with spermodermic cells; also the fresh-water Entomostraca, *Cypris vidua*, *Chydorus sphæricus*, *Canthocamptus minutus*, and *Daphnia vetula*.

Mr. T. Fiddian laid on the table Stanley's microscopic collecting-case; also a new machine for cutting circles of thin microscopic glass; and Mr. W. P. Marshall a further improvement in mounting and dissecting microscopes, designed by himself.

Academy of Natural Sciences of Philadelphia.

Microscopical Section.

Dec. 21st, 1868. Director, S. W. Mitchell, M.D., in the chair. Twenty members present.

Dr. J. H. McQuillen exhibited, in further illustration of his previous communication, slides of blood corpuscles of men and lower animals to which chloroform and nitrous oxide had been administered, to show that there was no morphological change in these bodies after administration of anæsthetics, as contended for by B. W. Richardson, Sansom, and others.*

Mr. W. H. Walmsley called the attention of the Department to the very great merits of Glycerine jelly as a medium for the preservation of every description of objects, animal or vegetable, and exhibited specimens of both. He made the following remarks:—"I was led to experiment with it about one year ago, owing to the unsatisfactory results obtained from the use of balsam in many classes of objects, its high refracting power rendering many delicate tissues invisible, which are seen perfectly in the jelly. At first I was not very successful, having followed the formulæ of Davies and other English authorities in making it; the intense heat of our early summer liquefied it, and spoiled many specimens. After many experiments, I arrived at a satisfactory result, the fluid readily jellying in an hour or two during the hottest days of August.

"The advantages of this medium I deem to be various and obvious, and that it combines within itself more than are possessed by any other with which we are as yet acquainted. Its preservative qualities I believe to be unsurpassed, for nearly every description of tissues or structure, animal or vegetable; it preserves the colours of the latter in absolute perfection, it is very readily prepared and used, it attaches the covering glass to the side with sufficient tenacity for all practical purposes, whilst the finishing ring of varnish will render it quite

* This paper will be found elsewhere in our pages.—Ed. M. M. J.

secure. It is equally available for objects requiring to be mounted in deep cells, and there is no danger of leakage, as is the case with all fluids; it can be readily removed from slide and cover with hot water, if necessary. The refractive powers of the glycerine are sufficient to render all inert structures transparent, whilst even the delicate lines upon the scales of a mosquito's wing are as distinctly visible as though mounted dry.

"Finally, I desire, in bringing the subject before the Department, and mentioning my experience with its use, to interest other members in the matter, to induce them to try it, and to bring together from time to time the results we may severally arrive at. For I conceive it to be almost as important to arrive at a means of *preserving permanently* objects suitably prepared for scientific observations, as to be able to prepare them for such observation without reference to their preservation. Since we can only hope to arrive at accurate conclusions by repeated study, not by one, but many observers, this can only be done by having the object suitably prepared and permanently preserved.

"The formula for making glycerine jelly is as follows:—

"Take one package of Cox's gelatine, wash repeatedly in *cold* water, then place in a vessel and add sufficiently *cold* water to cover it. Allow it to soak an hour or two, pour off superfluous water, add one pint of *boiling* water, place vessel on fire and boil for ten or fifteen minutes. Remove from fire, and when cool, but still fluid, add the white of an egg, well beaten, replace on the fire and boil until the albumen of the egg coagulates. Strain while hot through flannel, and add an equal portion by *measurement* of Bower's pure glycerine, and fifty drops of carbolic acid in solution; boil again for ten or fifteen minutes, and again strain through flannel, place in water-bath, and evaporate to about one-half, then filter into two oz. broad-mouth vials. (Cotton is the best filtering medium.)

"To use the jelly in mounting objects:—Place the stock bottle in a small jar of boiling water; when it becomes fluid, a sufficient quantity must be removed to the slide (previously warmed) with a glass rod; the object (previously soaked for some hours in equal parts of glycerine and distilled water with a few drops of alcohol) is to be placed in the drop of fluid jelly, a cover applied and slight weight placed upon it to exclude superfluous jelly. When cold, clean off the slide with a knife and wash in cold water; finish with a ring of gold size or shellac varnish.

"Dr. Carpenter cautions against use of Glycerin with objects of a calcareous nature, as it is a solvent of carbonate of lime."

Mr. Chas. Bullock remarked that it is important to give the gelatine frequent washings previous to use, to remove traces of sulphuric acid, which invariably remain from the process employed in its preparation.

Mitchell W. McAllister, S. Fisher Corlies, and Dr. J. G. Richardson, were this evening chosen members of the Department.

Prof. O. W. Holmes, of Boston, was chosen a corresponding member.

The State Microscopical Society of Illinois.

The following document, embodying the incorporation of the Society, has been forwarded to us for publication:—

Whereas, It is eminently conducive to the public good of a State to foster and encourage such Institutions in its midst as have for their object the dissemination, advancement, and promotion of sound and useful knowledge; and

Whereas, The cultivation of a public taste for scientific inquiry, research, and pursuits is especially to be commended as invaluable in its material and moral results to the State; and

Whereas, The persons hereinafter mentioned are associated for the purpose of affording assistance and encouragement to Microscopical investigations, by promoting that ready intercourse between those engaged in such pursuits, that not only are great advantages mutually gained, and an increasing interest in Microscopical pursuits largely maintained, but also information of the most valuable kind disseminated and perpetuated; therefore,

Section 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly,* That Hosmer A. Johnson, M.D., Nathan S. Davis, M.D., John H. Hollister, M.D., William C. Hunt, M.D., James V. Z. Blaney, M.D., Joseph W. Freer, M.D., H. Webster Jones, M.D., Thomas C. Duncan, M.D., Walter W. Allport, D.D.S., Ezekiel H. Sargent, chemist, and Messrs. George M. Higginson, Eliphalet W. Blachford, William E. Doggett, George F. Rumsey, Joseph T. Ryerson, Daniel Thompson, Henry H. Shufeldt, George A. Shufeldt, jun., Samuel A. Briggs, Henry F. Munroe, John Carbutt, John Robson, and James Hankey, all of the city of Chicago, so associated for the purposes aforesaid, be and are hereby formed into and constituted a body politic and corporate, by the name of "The State Microscopical Society of Illinois;" and that they and their successors, and such others as shall be legally elected by them as their associates, shall be and continue a body politic and corporate by that name for ever.

Section 2. The said Society shall have power to elect a President, and all such officers as from time to time may be deemed necessary for the more efficient conduct of its affairs and purposes.

Section 3. The said Society shall have a common seal, and the same may break, change, and renew at pleasure; and as a body politic and corporate, may sue and be sued, and prosecute and defend suits, both in law and equity, to final judgment and execution.

Section 4. The said Society shall have power to make all orders and bye-laws for governing its members and property, not repugnant to the laws of this State; and may expel, disfranchise, or suspend any member who, by his conduct, shall be rendered unworthy, or who shall neglect or refuse to observe the rules and bye-laws of the Society.

Section 5. The said Society may, from time to time, establish such rules for electing officers and members, and also times and places for holding meetings; and it is hereby empowered to take or

hold real or personal estate, by gift, grant, devise, or purchase, or otherwise, and the same or any part thereof to alien and convey: *Provided*, That the corporation hereby created shall not, at any one time, hold real estate the value of which shall exceed $100,000.

SECTION 6. The said Society shall have power to elect Corresponding and Honorary members thereof, in the various parts of the State, and of the several United States, and also in foreign countries, at their discretion; and Hosmer A. Johnson, or any other person named in this act, is hereby authorized and empowered to notify and call together the first meeting of said Society, with power to adjourn from time to time, as may be found necessary.

SECTION 7. This act shall take effect and be in force from and after its passage.

(Signed) F. CORWIN,
Speaker of the House of Representatives.

APPROVED March 31, 1869. (Signed) J. DOUGHERTY,
Speaker of the Senate.

(Signed) JOHN M. PALMER.

UNITED STATES OF AMERICA, } *ss.*
STATE OF ILLINOIS. }

OFFICE OF SECRETARY.

I, EDWARD RUMMEL, Secretary of State of Illinois, do hereby certify that the foregoing is a true copy of an act to incorporate the State Microscopical Society of Illinois—approved March 31st, 1869—now on file in this office.

In witness whereof, I hereto set my hand and affix the Great Seal of State, at the City of Springfield, this 8th day of April, A.D. 1869.

(Signed) EDWARD RUMMEL,
Secretary of State.

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NEW BOOKS, WITH SHORT NOTICES.